THE ENGINEER.

The Shipping, Engineering and Machinery Exhibition at Olympia.

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THE twelfth Shipping, Engineering and Machinery Exhibition at Olympia, London, which was opened yesterday by the Earl of Athlone, occurs towards the end of that part of the year when the meetings of institutions, societies, and other bodies are least numerous and therefore provides engineers with the opportunity to meet their friends and acquaintances after a separation possibly extending to several months. Fresh subjects are available of which to talk, there are holidays, good or bad, to discuss, and should the conversation languish there are always the objects on a nearby stand to reinvigorate it. In fact, for a fortnight Olympia becomes the meeting place of engineers from all over the country, from the Continent, and, we hope and believe, from many other parts of the world as well. Each biennial Exhibition, though similar at first sight to its predecessors, has an individual character. This year, for instance, electrical engineers may suffer some slight disappointment, for the names of several familiar firms are absent from the catalogue. But against this loss may be placed the outstanding merit of the oil engine exhibits. Practically every well-known oil engine firm in the country is represented, while at least one firm not previously interested in the high-speed type has such an engine on its stand. Looking at the oil engine exhibits as a whole, it is interesting to note that a revival of interest in the horizontal type appears to be on the way, for several examples are to be seen, one of considerable size. The development of the high-speed type is proceeding as rapidly as ever, and an examination of the stands is sufficient to show that it is applied to a range of duties in the marine, industrial, and transport fields almost, if not quite, as wide as that of its slow-speed cousin. At the same time it is finding new spheres of usefulness for which the greater weight and size per horse-power of the slow and medium speed engines makes them unsuitable. In consequence of the importance of the oil engine exhibits a considerable proportion of this Supplement is devoted to them.

In other directions the Exhibition is not wanting in interest. There is the usual display of steam engineering plant. The instrument section will be particularly interesting to those with a liking for cunning mechanisms and the ingenious application of physical and chemical facts to engineering usage, and there are pumps and refrigerators, welding and metal cutting devices, and a host of such things as belting compounds, soldering fluxes, &c. British machine tools are unfortunately absent for the most part, owing to the affiliation of the majority of the firms in Associated British Machine Tool Makers, Ltd., while the display of foreign tools is not, we think, so good as in previous years, possibly as a result of the imposition of tariffs. Some visitors, no doubt, will consider the Exhibition less good than its predecessors; others will claim it to be the best of many. We leave our readers to judge for themselves.

KELVIN, BOTTOMLEY AND BAIRD, LTD.

One of the principal exhibits of Kelvin, Bottomley and Baird, Ltd., of 18, Cambridge-street, Glasgow, is the authentic "Lord Kelvin" dry card compass with all the latest improvements, including the coach spring suspension and mattress pivot. It is suitable for use where there is severe vibration. Liquid compasses, including the "Stabol" standard dead beat instrument, which is claimed to be remarkably free from disturbance under the most exacting conditions of vibration, and liquid steering compasses, including the "Vertical Card" pattern, in which an optically projected image of the card is shown in the vertical plane, are other exhibits. There are also compasses for use in small yachts and motor boats, and on aircraft, and sounding machines with all the latest improvements. The latter are of the motor and hand-driven types for sounding from the bridge or aft. Among them is a $2\frac{1}{2}$ H.P. machine with 500 fathoms of wire, for use in high-speed vessels.

A new hotwell gauge exhibited has been designed to overcome the difficulties associated with the application of such a gauge to hotwell tanks working on totally enclosed systems. These difficulties arise chiefly from the vacuum in the vapour space above the water surface in the tank, necessitating a pressure equalising connection between this space and one side of the gauge and from the liability of this connection to become partly flooded by condensation from the warm hotwell vapour. When this connection is of considerable length and when for the sake of convenience the pipe is small this tendency is serious. Consequently a system has been devised in which the connections between the gauge and tank are maintained in a "drowned" or intermittently filled condition. Essentially the gauge consists of a mercury U tube, the respective sides of which are connected to the hotwell tank at its lowest and highest points by means of two brass pipes. Both pipes pass through the bottom of the tank, but while one terminates just above the bottom, the other passes up as an internal standpipe and ends in an overflow orifice near the top of the tank. Near the gauge a water circulating pump is inserted in a short by-pass line provided with two cocks, disposed between the two ends of the tube. With a single setting these cocks serve to by-pass the U tube and to establish a continuous circuit from the bottom to the top of the tank *viâ* the external pipe line.

By operating the pump this circuit can then be entirely flushed and filled with the hotwell water drawn from the bottom point and be delivered to the top point of the hotwell tank, where it overflows freely into the main body of the tank. The cocks are then made to close the by-pass and to introduce the U tube into the "drowned" circuit. Under these conditions the vacuum within the tank operates equally on each side of the gauge and produces no effect on the reading. On the side connected to the top point of the tank the gauge is subjected to the head of water corresponding to the height between itself and the top of the tank, whilst on the other side connected to the bottom point of the tank it is subjected to the head of water corresponding to the height between itself and the actual level of the water in the tank. As the gauge reading is the difference of these two quantities, it is a direct measure of the distance from the tank top to the existing water level; in other words, the quantity of water contained in the tank.

Other gauges shown are suitable for indicating the quantity of fuel oil or other liquids in tanks and for giving boiler water levels at any convenient position. Space does not permit us to make reference to several additional exhibits, which consist, among other things, of a vibrometer for vibration tests, semaphores, morse lamps, petrol gauges for aircraft, clocks, and telescopes.

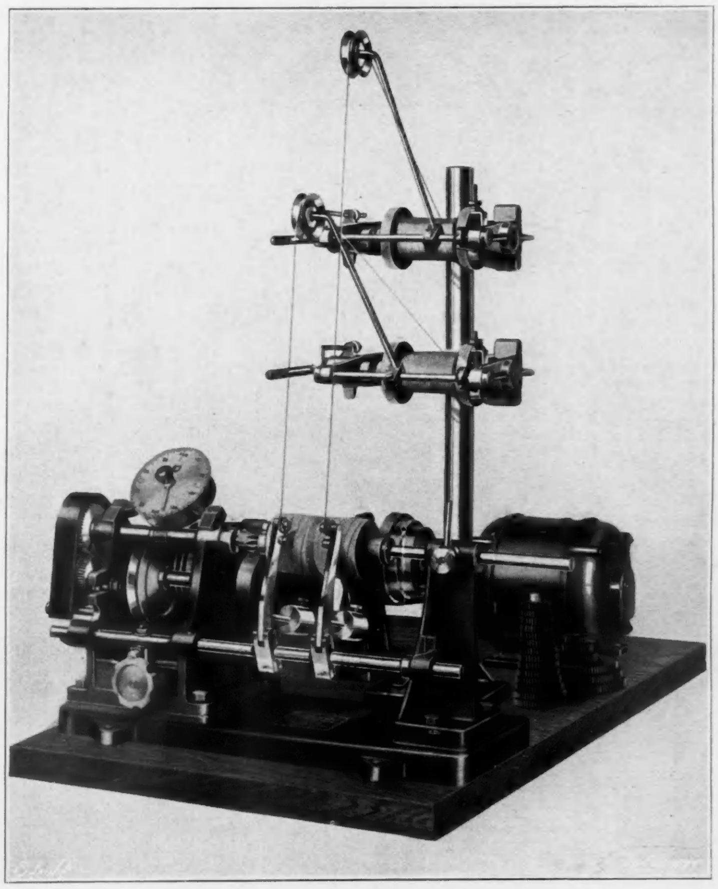


FIG. 1—CRISS-CROSS COIL WINDER—AUTOMATIC COIL

THE AUTOMATIC COIL WINDER AND ELECTRICAL EQUIPMENT COMPANY, LTD.

A comprehensive range of coil winding machines is being shown by the Automatic Coil Winder and Electrical Equipment Company, Ltd., of Windsor House, Douglas-street, S.W.1. Two new machines are the criss-cross coil winder and the Douglas multiple winder, shown in Figs. 1 and 2 respectively. The former, which can be hand or power driven, winds self-supporting wave-wound coils composed of from $\frac{3}{32}$in. to approximately $1\frac{3}{4}$in. width of covered wire of 46–20 S.W.G. As the wire reel carriers form separate units and as the stand will accommodate from one to four of them, one coil can be wound alone or two, three, or four coils may be wound simultaneously. Each of the reel carriers can be adjusted independently and can be made to take up any required position. The winder is driven through machine-cut gears. A sliding back centre is provided and any type of driving mandrel can be fitted to the driving spindle, or tubes can be held between the centres. Automatic brakes give the required tension on the wire and prevent overrun of the supply wheels when the machine is stopped. A worm-driven revolution counter to be seen on the left of the machine can be set to zero on the completion of winding.

The "Douglas" multiple-coil winder shown in Fig. 2 is for winding small coils from $\frac{1}{8}$in. to $\frac{3}{4}$in. in width and any number of coils within the range 1 to 4 can be wound simultaneously, according to size with wires of 48 to 32 S.W.G. A special motor, capable of running at 6000 r.p.m. and controlled by a foot pedal, forms the winding head, whilst an adjustable back centre supports the winding mandrel. The wire guide arms are capable of lateral adjustment. As in the case of the other machine, the wire reel carriers form separate units and the stand will take from one to four of them. Each reel carrier can also be independently adjusted to any required position and is fitted with an automatic brake which gives the wire the required tension when the machine is stopped. A five-figure direct-reading counter is to be seen on the extreme left of the machine.

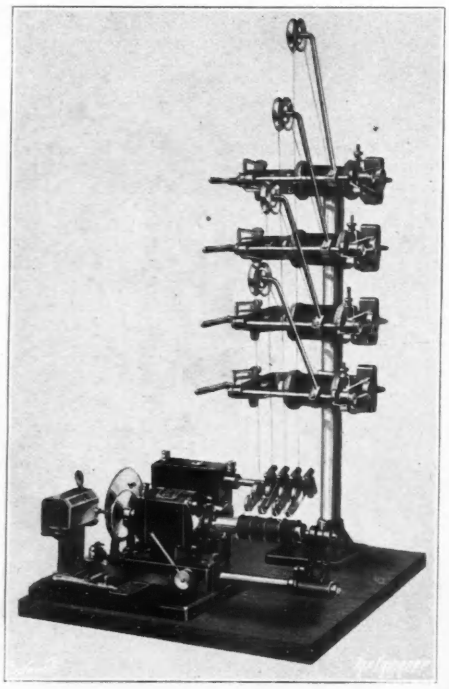


Fig. 2—Multiple Coil Winder—Automatic Coil

The Bergius Company, Ltd.

The range of engines displayed on the stand of the Bergius Company, Ltd., of 254, Dobbies Loan, Glasgow, C.4, includes a Kelvin sleeve valve engine for petrol, gasoline, or benzine fuels, Kelvin-Ricardo engines for paraffin, petroleum, or kerosene fuels, and Kelvin-Diesel engines for heavy fuel oils.

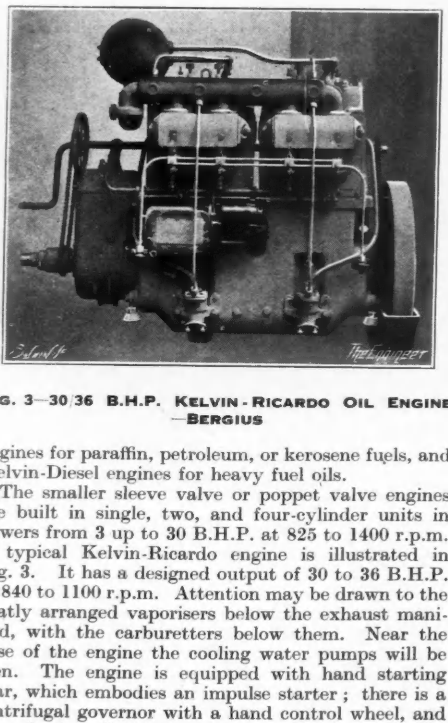


Fig. 3—30/36 B.H.P. Kelvin-Ricardo Oil Engine —Bergius

The smaller sleeve valve or poppet valve engines are built in single, two, and four-cylinder units in powers from 3 up to 30 B.H.P. at 825 to 1400 r.p.m. A typical Kelvin-Ricardo engine is illustrated in Fig. 3. It has a designed output of 30 to 36 B.H.P. at 840 to 1100 r.p.m. Attention may be drawn to the neatly arranged vaporisers below the exhaust manifold, with the carburetters below them. Near the base of the engine the cooling water pumps will be seen. The engine is equipped with hand starting gear, which embodies an impulse starter; there is a centrifugal governor with a hand control wheel, and the spherical silencer is water cooled. This engine is the largest Kelvin-Ricardo shown, the other three being two 15 to 18 B.H.P. engines with two and four cylinders and a $7\frac{1}{2}$ to 9 B.H.P. twin-cylinder unit. The two largest engines on the stand are of the Kelvin-Diesel type, the design of which has been developed by Mr. Walter Bergius in collaboration with Mr. H. R. Ricardo. We illustrate on page ix, Fig. 34 the four-cylinder 88 B.H.P. unit. The complete range includes one to six-cylinder units, designed with an output of 22 B.H.P. per cylinder at 750 r.p.m. The bore of the cylinders is 6in., with a stroke of 9in. A deep narrow crank case is employed, to which the cylinder casings are bolted. The valve gear is of the overhead type, operated by push-rods. The balanced crank shaft is of large dimensions and the whole of the lubrication for the bearings and running parts is automatic, with a plunger pump feed. The water circulating pump is of the ram type and works with a large air chamber. Means are provided to regulate the flow of water to the jackets, thereby facilitating starting operations and running at low engine speeds. The reverse gear is of the standard Kelvin pattern.

The Submarine Signal Company (London), Ltd.

The majority of our readers are already familiar with the principle of the "Fathometer" depth sounding apparatus manufactured by the Submarine Signal Company (London), Ltd., of 9, Victoria-street, and exhibited at Olympia. It will be remembered that, to put it very briefly, an electric oscillator is installed in a suitable position near the keel of a ship and sends out a sound at convenient intervals. Each sound, as reflected from the sea bed, is received by a hydrophone, and the time elapsing between the emission and reception of the sound is electrically measured. This time interval is, of course, directly proportional to the depth beneath the keel of the vessel, and, in fact, the electrical indication is automatically converted at once into a visual one on an instrument, usually mounted in the chart-room. Since they were first produced, considerable improvements have been made to "Fathometer" sounding devices. Costs of manufacture have been reduced, while at the same time ease of installation has been so carefully studied that it is now possible with very little trouble to fit such ships as small trawlers and the like with the device. For instance, the "Coastal" type, indicating depths up to 90 fathoms, has an all-mains amplifier; and a transmitter and hydrophones sufficiently small to be mounted between the frames of the ship. No cutting of the ship's skin, and therefore no dry-docking, is necessary. The instrument illustrated in Fig. 4 is especially designed for such craft as Channel steamers and coastal shipping, and gives a finer and more accurate indication of shallow water depths up to 45 fathoms. It is interesting to note that among other ships fitted with this particular type of instrument is the m.y. "Trenora," recently described in our columns.

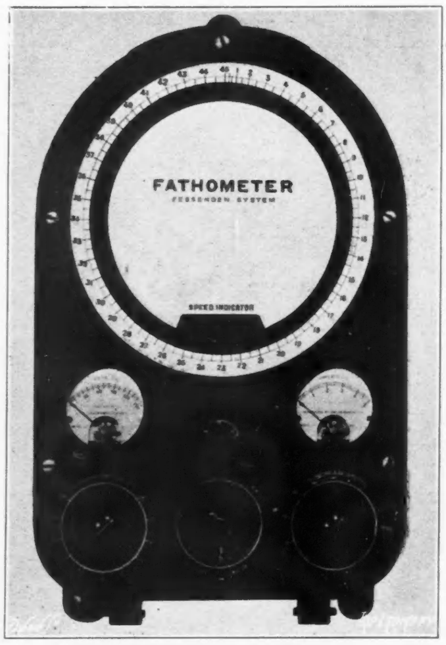


Fig. 4—Shallow Water "Fathometer"—Submarine Signal

B.E.N. Patents, Ltd.

The exhibits of B.E.N. Patents, Ltd., consist of a selection from the complete range of portable and fixed spray-paint plant and equipment. Two particularly interesting exhibits are the "Pneu-Matic 12" portable two-gun spray-paint plant, and the "Handi-Spray" outfit. The "Pneu-Matic 12" is designed for multi-gun spray work, as well as for the operation of pneumatic scrapers, riveters, and light chippers, and for all cases where mobility is of much importance. The single-cylinder, air-cooled compressor is belt-coupled to a $1\frac{1}{2}$–2 H.P. air or water-cooled petrol engine, both being securely bolted to a rigid all-steel channel base mounted on pneumatic-tired wire wheels. The two air receivers are of tubular construction and are carried lengthwise along the underside of the channel base, thus affording an exceptionally long passage for the compressed air. An oil and water separator is fitted at the forward end of the machine, and is provided with two outlet cocks for air hoses, thus ensuring the delivery of dry air that is cool and free from oil or condensed water, for which latter drainage cocks are provided. Regulation of air pressure is effected by means of a diaphragm head unloader, the controller being fitted alongside the pressure gauge in a position convenient to the operator. The engraving—Fig. 5—shows a side view of the equipment.

The "Handi-Spray" outfit is a self-contained and compact unit capable of handling cellulose lacquers, paints, and distempers. It comprises a B.E.N. type A.O. single-cylinder, air-cooled compressor, a $\frac{1}{4}$ H.P. electric motor controlled by a convenient double-pole switch, and an efficient oil and water separator with pressure gauge and relief valve. The outlet from the compressor is connected to the oil and water separator by a coiled copper after-cooler carried round the fan fly-wheel in such a manner that the air is thoroughly cooled and cleaned before being delivered to the spray gun. The complete unit is mounted on a light, rigid steel base carried on four rubber buffers, the drive from the motor to the compressor being taken by an endless silent "V" belt. Provision is made for belt tensioning. As it is only 18in. long, $9\frac{3}{4}$in. wide, 16in. high, and weighs 74 lb., the outfit justifies its title.

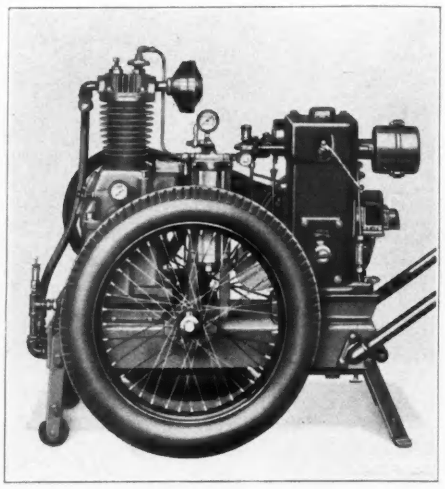


Fig. 5—"Pneumatic 12" Spray-Paint Plant —B.E.N. Patents

The Renold and Coventry Chain Company, Ltd.

Chains in an almost bewildering variety of applications are to be seen on the stand taken by the Renold and Coventry Chain Company, Ltd., of Didsbury, Manchester. For power transmission chains suitable for horse-powers up to 1200 are to be seen, while the standard range of conveyor chains covers breaking strengths from 1700 lb. up to 85,000 lb. Together with chain couplings for horse-powers up to 600 and speed transformers for increasing or decreasing speed, there is altogether an excellent demonstration on the stand of the capabilities of chains.

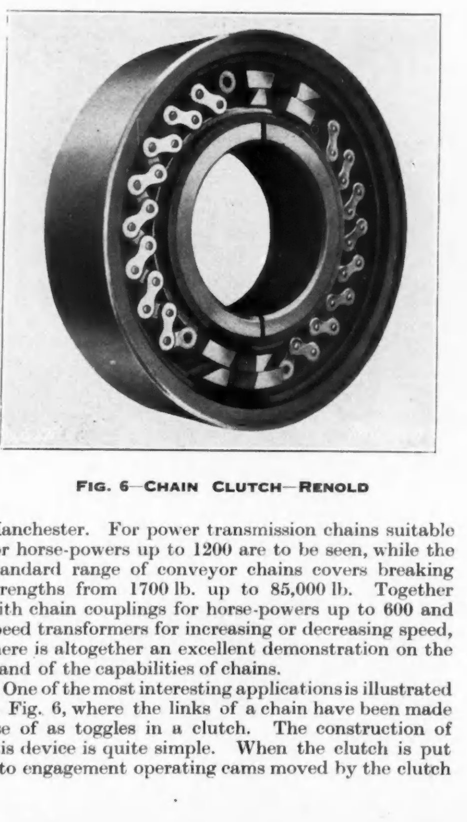


Fig. 6—Chain Clutch—Renold

One of the most interesting applications is illustrated in Fig. 6, where the links of a chain have been made use of as toggles in a clutch. The construction of this device is quite simple. When the clutch is put into engagement operating cams moved by the clutch fingers compress the chain. Each link then acts as a toggle pressing outwards on to an expanding friction ring that grips the internal diameter of one member and pressing inwards to contract a friction ring to grip the external diameter of the other member. The numerous points of contact which the chain makes when under compression ensure uniform pressure throughout the circumference of the friction rings. Although either side of the clutch may be the driver, it is normally mounted on the driven shaft as close as possible to the shaft bearing. A double engagement bobbin is also made for use where alternate engagement between two drives is required. The largest clutch is made for a maximum rating of 50 H.P. at 600 r.p.m. Another interesting application of chain to be seen on this stand is the push-pull remote control gear suitable for the operation of clutches and similar units. The roller chain is enclosed in weldless steel tubing and the system may be applied with a neatness comparable with that of an electric wiring system. A maximum effort of 100 lb. may be exerted in one direction and of 20 lb. in the other and a maximum of three bends can be used in any installation. These bends may be in two planes.

Murex Welding Processes, Ltd.

On the stand of Murex Welding Processes, Ltd., of Ferry-lane Works, Forest-road, Walthamstow, E.17, there is a comprehensive range of welding plant, electrodes, and welded objects. A full-sized portion of a cargo ship's midship bilge section shown is similar to that exhibited some months ago in Glasgow and described in a paper read by Mr. Adam, chief ship surveyor for the British Corporation Register of Shipping and Aircraft, before the Scottish Institution of Shipbuilders and Engineers. The exhibit at Olympia differs from that at Glasgow, in that the vertical tank side plate is shown as it would appear in laying off; and by the carrying outboard of the tank top strake to form a girder flange and the under scarfing thereof by the side frame knees. This assembly offers a jointing system impossible of attainment in a riveted ship without the introduction of a line or lines of rivets in a particularly undesirable position.

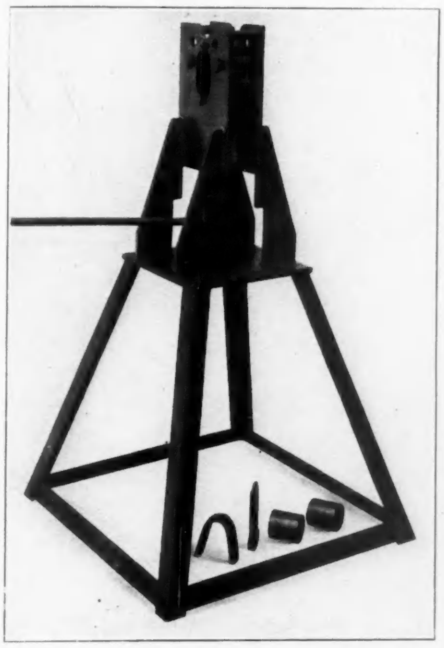


Fig. 7—Machine for Testing Welds—Murex

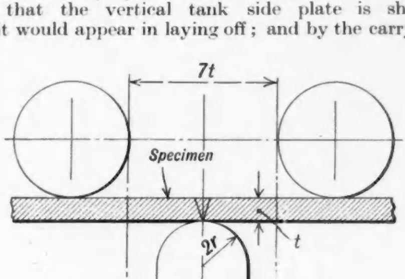
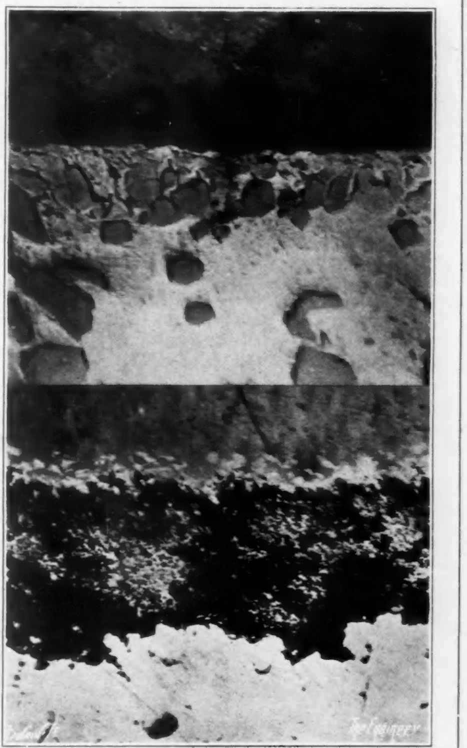


Fig. 8—Diagram Showing Arrangement of Weld Testing Machine—Murex

The welding plant shown includes a 600-ampère single-carcase motor generator set for high-speed welding, a portable static transformer welding set, and a detachable unit motor generator set for welding railway crossings, structures, &c. An automatic coal gas cutting machine lent by the British Oxygen Company, Ltd., is another exhibit. Demonstrations are being given of the welding of all kinds of special steels and alloys by the company's patented electrodes, including one of straight gap welding in thick plate. Several new types of electrodes for arc welding are being used. A hand operated testing machine shown has been designed to provide a simple, rapid, and inexpensive method of carrying out a bend test as a measure of the ductility of weld metal and welded joints. The bend test as applied to weld coupons (usually butt-welded plates with a single V) is said to be the most suitable method of evaluating that quality of weld metal or of a welded joint. The bend test offers the advantage that by a single test the ductility of the weld metal as deposited in practice and that of the joint as a whole can always be obtained, whereas in the tensile test no measure of ductility is obtained if the specimen breaks outside the gauge points. The machine shown in Fig. 7 consists of a mild steel table on which a hydraulic jack is mounted, the head of the jack being slotted to take a plunger which makes contact with the underside of the specimen along the welded joint, as shown in Fig. 8. The radius of the plunger is usually $2t$, as indicated, whilst the clearance between it and the rollers shown in Fig. 8 should be approximately $1\frac{1}{2}t$, the specimen being tested so that the upper part of the V is in tension. The most suitable methods of determining the degree of ductility consist of (1) measuring the angle of bend, and (2) the elongation of the outer fibres. The first method is well known and does not call for description, but the second method may need explanation. It consists in scribing, or preferably marking with a rubber stamp, fine lines across the specimen equidistant from the centre line of the weld and at a distance of t, $2t$, or $3t$ apart. During the testing of a specimen bending is continuous until any defects which open up are enlarged to a width of $\frac{1}{16}$ in., when the test is stopped and the specimen removed for the determination of the ductility of the welded joint, measurement with a flexible rule being a convenient method of determining the elongation.

The Soldo Company.

The compound known as Soldo, and made by the Soldo Company, of Sicilian House, Southampton-row, London, is non-acid and consists of a powder which is a combination of fluxes and metal. It is claimed to be suitable for tinning all metals, except aluminium, even when rusty, corroded, greasy or oily, with no previous preparation whatsoever. The method of use consists of heating the metal to be tinned in a gas flame to a temperature judged to be sufficient. It is then removed, and "Soldo," which is a greyish white powder, is sprinkled over the area. Fumes are evolved, the compound appears to melt, and a continuous tinned surface is produced. Tests were conducted at the National Physical Laboratory on the tinning of phosphor bronze commercial rolled strip, "Ohmal" strip, manganese bronze commercial rolled strip, steel, cast iron, and rusty steel. Microscopic examination of the joints showed in all cases interpenetration between the metal and tin. With manganese bronze the extent of the interpenetration was observed to be four to five times, and with phosphor bronze about twice as great as when ordinary workshop methods of tinning were employed. The upper microphotograph—Fig. 9—shows tinned manganese bronze at a magnification of × 600. Diffusion has proceeded to a considerable depth. The other engraving—Fig. 10—at a smaller magnification (× 200) shows manganese bronze jointed to cast iron. The upper part is the bronze, the lower part cast iron, and the central region consists of tin, the black areas, according to the N.P.L. report, being probably the results of interpenetration with the cast iron.



Figs. 9 and 10—Microphotographs of Tinned Surfaces—Soldo

C.A.V.-Bosch, Ltd.

Magnetos as shown in Fig. 11, with stationary windings and cobalt steel magnets, are being exhibited by C.A.V.-Bosch, Ltd., of Acton, W.3. The contact breaker and distributor form a separate unit which on a four-cylinder engine runs at half the usual speed and at one-third of that speed on a six-cylinder engine. A considerable reduction in the wear of the moving parts is claimed to be secured and maintenance is reduced to a minimum. Automatic advance mechanism can be fitted to the distributor instead of to the main driving shaft, with the result that the automatic mechanism is not subjected to the relatively large moment of inertia and large driving torque associated with the main rotor. As on the fixed part of the machine space is not restricted, a heavy primary winding is permissible and the secondary can be provided with a liberal amount of insulation. A greatly improved slow-speed performance and a wide range of ignition advance are the makers' principal claims. Other exhibits consist of car dynamos, switchboards, starters, and fuel injection equipment.

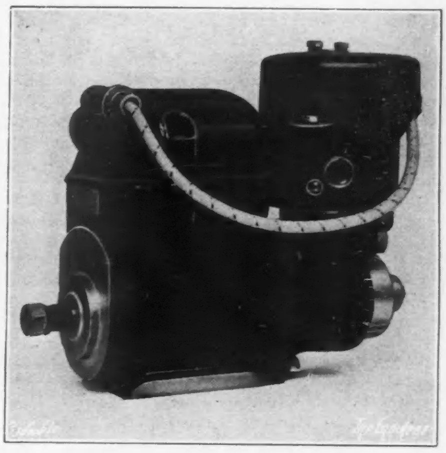


Fig. 11—Magneto—C.A.V.-Bosch

John Lilley and Son, Ltd.

Nautical instruments of many kinds are to be seen on the stand taken by John Lilley and Son, Ltd., of North Shields. The "Unit" compass in its several forms takes pride of place, but the many other instruments such as the "Q.E.D." pelorus for taking bearings and the measuring of horizontal angles, &c., and the "Sceptre" depth recorder, particularly in its adaptation for the use of yachtsmen, deserve attention.

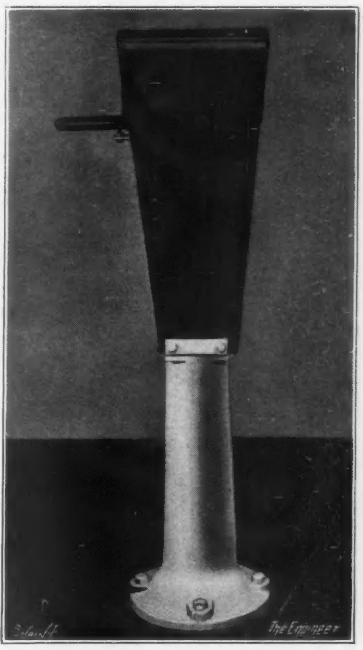


Fig. 12—Stern Fog Signal Emitter—Lilley

It may be remembered that in January, 1934, under the new International Agreement for the

Safety of Life at Sea, vessels over 350ft. long will have to carry a stern fog signal. It will easily be appreciated even by those whose seafaring adventures have been limited to an occasional trip in a cross-Channel boat, that if a stern fog signal is to be effective the noise it gives out must readily be differentiated from other similar signals at present in use, such as Klaxons, steam whistles, syrens, and the bell mounted forward. In the approaches to all seaports there is inevitably a considerable congregation of shipping at the coming down of fog to limit visibility. Although an experienced sailor hearing the sound of the foc'sle bell through the fog and knowing how the tide is flowing, may be able to guess successfully how the vessel lies, there can be no doubt that he will be greatly assisted in avoiding the invisible ship and finding a safe anchorage for his own if the noise of the bell is immediately followed by the sounding of a gong on the poop. John Lilley and Son, Ltd., have designed and are showing at the Exhibition the gong illustrated in Fig. 12. It has been designed to fulfil all the requirements of the Board of Trade, is compact, has no loose parts, such as hammers and clappers, and is capable of being fixed permanently to the ship in the best position. While its audibility at a distance is as great as that of the bell, the sound it gives out is readily distinguishable. Extra value is given to the equipment by the fact that it is capable of emitting two notes, one high and the other low. Thus distinctive sounds may be made, the Morse alphabet used, or the name of the vessel announced.

PETTERS LTD.

A wide range of oil engines designed for stationary, marine, and lighting services is displayed on the stand of Petters Ltd., of Westland Works, Yeovil. In the series of Atomic two-stroke airless-injection oil engines, which now comprises sizes from 5 B.H.P. up to 540 B.H.P., two examples are shown running. These include a four-cylinder 195 B.H.P. direct-reversing and cold-starting marine engine, and a two-cylinder 180 B.H.P. engine designed for industrial purposes, while the smallest of the series, a new engine of 5 B.H.P. output, is exhibited for the first time. The marine engine serves to show the single wheel control system, which consists of a single hand wheel mounted at the forward end of the engine, which enables all manœuvres, both ahead and astern, to be carried out by the attendant in a minimum of time. Demonstrations that the complete reversal from full ahead to full astern or *vice versâ* can be carried out in approximately four seconds are being given on the stand. The special means of governing is combined with a controlled fuel admission for starting and enables the engine to be worked smoothly over a wide range of speed variation, always remaining under the control of the governor. The principle of the single-wheel control system for starting and manœuvring was fully described in our issue of February 20th, 1930, but the engine shown at Olympia embodies the firm's newest practice both in design and manufacture. It has a designed output of 195 B.H.P. at 375 r.p.m., with 10in. bore cylinder and 14½in. stroke.

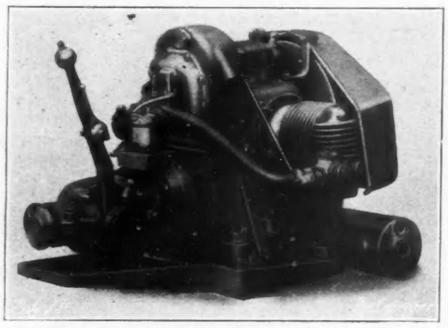


FIG. 13—4 B.H.P. MARINE PETROL ENGINE —PETTERS

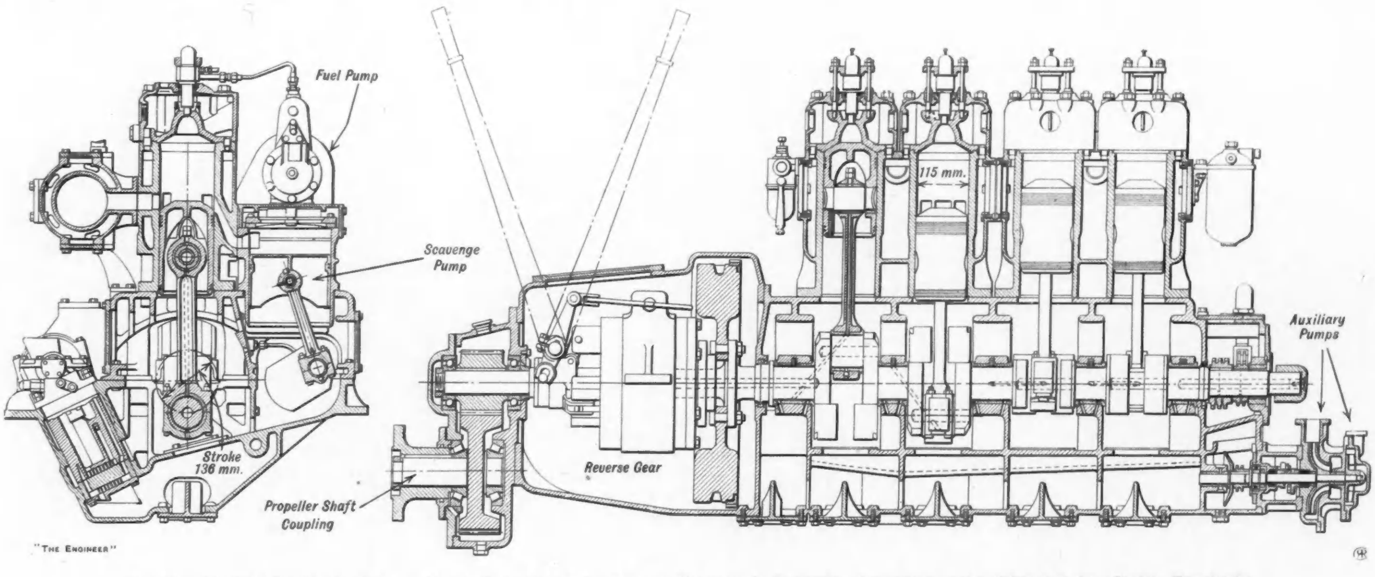


FIG. 14—40 B.H.P. HIGH SPEED TWO-STROKE C.I. ENGINE WITH GLENIFFER REVERSE AND REDUCTION GEAR—PETTERS

A special feature of the 180 B.H.P. two-cylinder engine is the improved water-jacketed cover for the cylinder head. The upper portion of the jacket is made of steel, and is so constructed that it can be easily and quickly removed to give free access to the water spaces in the cylinder head. In districts in which the cooling water is hard and there is a tendency towards "furring up," or in muddy estuary waters, the new type of head which has been adopted in all the larger engines has been found to possess many advantages. The fuel atomisers are also arranged in such a way that the area in the cylinder heads around the nozzles is well cooled, thus minimising the possible formation of carbon deposits on the injection nozzles.

Another exhibit of interest is the new two-stroke, four-cylinder, high-speed compression-ignition engine, which is shown in section in Fig. 14 and complete with a Gleniffer reverse and reduction gear in Fig. 29, page viii. It has an output of 40 B.H.P. at 1000 r.p.m. and a cylinder bore of 115 mm. with a stroke of 136 mm., operating on the two-stroke airless-injection principle with Bosch fuel injection pumps and nozzles. As will be seen from the drawing, the engine is of the separate scavenge pump type, which eliminates crank case compression. The neat arrangement of the scavenge pump chain drive is notable, and the strongly ribbed crank case and the engine-driven auxiliary pumps can be seen in the drawing. The fuel pump is mounted on the top of the scavenge air casing and is also chain driven from the crank shaft. A standard governor gear with hand speed control is attached to the fuel pump. Alongside can be seen the twin air filters, which are of the Vokes pattern. The Gleniffer type reverse and reduction gear, which is shown in section in Fig. 14, is designed to reduce the running speed of 1000 r.p.m. to a propeller speed of 500 r.p.m.

In Fig. 13 we illustrate the new four-stroke 4 B.H.P. 1500 r.p.m. air-cooled marine type petrol engine, which has a cylinder bore of 65 mm. and a stroke of 82 mm. The cylinders are offset 180 deg., so that a large main bearing area is given. The self-contained drive and clutch gives a propeller speed of 750 r.p.m. Our engraving clearly shows the deep ribbing of the cylinder casing and head, and the cowling which deflects over the ribs the air current generated by the fly-wheel, which is furnished on the outer side with a series of turbine nozzles to which air is fed through the centre of the cowl cover. Extensive tests with this engine have shown excellent results under widely varying conditions. The elimination of water cooling with the necessity for a water circulating pump with the piping and controls certainly gives a considerable saving in weight. With this type of engine a Zenith carburetter and a B.T.H. magneto are employed, the fuel control lever being attached to the clutch handle by means of a Bowden wire connection.

Another new exhibit is the 1-kW automatic lighting set, working on the floating battery principle, which we illustrate in Fig. 15. It is also made in a 2-kW size. The plant comprises a Petter "Universal" air-cooled petrol engine working on the four-stroke principle coupled direct to a shunt-wound dynamo with special series coils for starting. When the dynamo has attained its ordinary speed, to give the correct voltage, the starting coils are cut out and the dynamo runs as a shunt machine suitable for battery charging. The voltage is controlled by a special governor connected in series with the load, which maintains a constant voltage within reasonable limits by varying the engine speed according to load.

The switchboard, which is shown in the upper part of Fig. 15, is of the wall mounting type and contains both a charge and discharge ammeter, a voltmeter, charge and discharge fuses, and a master relay for starting and stopping the plant, with a safety switch to prevent the battery from being over-discharged in the event of failure of the plant. The first few lights are taken from the battery, but upon the load reaching a certain predetermined point the set starts up and the dynamo takes over the load, thus relieving the battery. Provided the load demanded is not greater than the output capacity of the dynamo, the battery also receives a charge, which keeps it ready for carrying the lighter loads and again starting the set. When the load is reduced to a predetermined low point the engine stops, the light being again supplied from the battery.

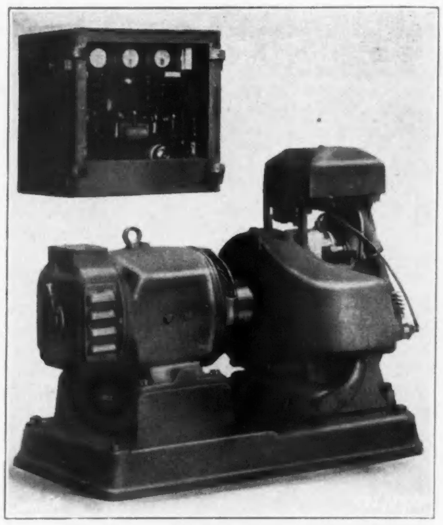


FIG. 15—1-kW LIGHTING SET—PETTERS

PHILIPS LAMPS, LTD.

Visitors interested in the use of X-rays in connection with engineering should not fail to inspect the exhibits of the X-ray and welding department of Philips Lamps, Ltd., of 145, Charing Cross-road, W.C.2. Simple and compact apparatus is shown for the examination of ship's plates and welds in steel up to ¾in. thickness. The use of the apparatus does not call for special skill, and, needless to say, the method is non-destructive. The apparatus is claimed to be invaluable in shipyards and in the testing department of engineering works. Mobile and stationary examples of the largest unit—the "Makro 200," with which 4in. of steel can be penetrated—are made for the examination of castings, forgings, riveted and welded boilers.

An exhibit of interest to metallurgists and works chemists is the Philips crystallographic equipment, which has brought X-ray crystal analysis within the range of the ordinary works laboratory. Like all the X-ray equipment made by the firm, it is completely shockproof and very compact. Pictures are also on view showing the results of X-ray tests on welds, rivets and castings.

Another exhibit is the rectifier welding set described in our issue of August 18th. The apparatus is smaller than a motor generator set of the same capacity, namely, 200 ampères, and as it operates from three-phase mains, it gives rise to a balanced load. A smaller set, working on the same principle, for welding thin plate, is also shown.

FOSTER INSTRUMENT COMPANY.

Among the indicating and recording temperature measuring apparatus shown by the Foster Instrument Company, of Letchworth, Herts, is a new multi-point recorder with a 7in. strip chart on which as many as six records can be produced, each printed in a different and clearly distinguishable colour. The instrument—shown in Fig. 16—is operated by an electric motor, through change-speed gearing, which enables the chart to be run at a suitable normal speed for production work or at a considerably higher speed for research purposes or for special batches of work demanding a high degree of temperature accuracy. Special automatic devices serve to lock all moving parts during transport and to protect the sensitive movement whilst the chart is being changed. Models of the "Introscope" for the detailed examination of the internal surfaces of tubes, rifle bores, high-pressure gas cylinders, &c., are also shown.

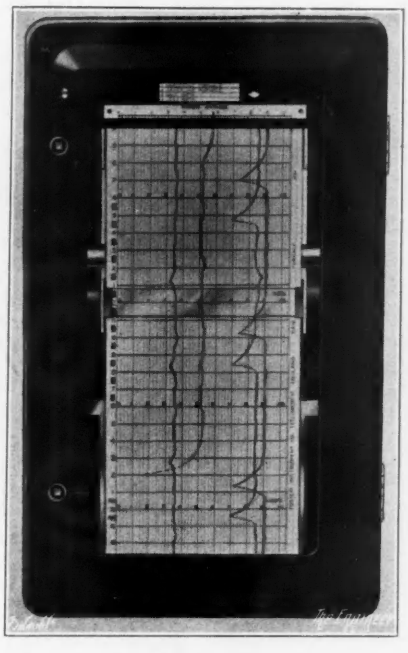


FIG. 16—MULTI-POINT TEMPERATURE RECORDER—FOSTER

L. GARDNER AND SONS, LTD.

Several engines of the high-speed variety are exhibited by L. Gardner and Sons, Ltd., of London and Patricroft, and also a three-cylinder 54 B.H.P. 400 r.p.m. heavy oil engine of the vertical marine type running on the two-stroke cycle. The high-speed engines comprise an eight-cylinder, giving 136 B.H.P. at 800 r.p.m.; a six-cylinder of 102 B.H.P. at 1700 r.p.m.; and a four-cylinder unit delivering 38 B.H.P. at 1000 r.p.m., all of which are adapted for marine use; and a $9\frac{1}{2}$ B.H.P. single-cylinder engine coupled to a dynamo and running at 1000 r.p.m. Although primarily designed for marine use, these engines are quite suitable for a number of other purposes, such as electricity generation, rail transport, ships' auxiliaries, and road transport. The engine illustrated in Fig. 32, page ix, is the six-cylinder, and the type in the makers' nomenclature is L.W. This engine is much used for road vehicle propulsion and many of its details have been specially studied from the point of view of a lorry driver. By the fitting of compression relief and inlet valve timing alteration devices it is claimed that to start the engine by hand is less arduous than to perform the same operation on a petrol engine. So easy is hand starting, in fact, that many lorries are not equipped with electrical gear. The engine has a cylinder bore of $4\frac{1}{4}$in. and a stroke of 6in. and the R.A.C. rating is $43\frac{1}{2}$ H.P. It is of the single-cell type and, according to the makers, has a fuel consumption of less than 0·380 lb. per B.H.P. per hour. The weight of the six-cylinder model under discussion, without dynamo or electric starter, is 150 lb. inclusive of the fly-wheel, so that it has a very low power to weight ratio. It will be noticed from the engraving that the cylinders are cast in blocks of three. For making up four-cylinder engines twin blocks are also made. The cylinder heads are made in blocks to correspond. There is, we think, no need to refer in detail to the design of the engine, which is, of course, constructed on sound principles in accordance with modern practice. As we have already mentioned the engine exhibited is intended for marine purposes. It is therefore fitted with a reverse gear.

THE NATIONAL GAS AND OIL ENGINE COMPANY, LTD.

The largest exhibit on the stand of the National Gas and Oil Engine Company, Ltd., of Ashton-under-Lyne, is a vertical six-cylinder "F A" type heavy-oil engine, designed to develop a constant output of 335 B.H.P. at 428 r.p.m. The cylinders have a bore of 11in. and a stroke of 15in., and at the full rated load the guaranteed fuel consumption is 0·39lb. per B.H.P.-hour. The bed-plate is a one-piece casting, which carries within it the crank shaft bearings, while the one-piece column which is bolted to it is bored to receive the loose liners. A feature of the cylinder covers is their deep section, which allows for the housing of the exhaust and air inlet valves, which have loose cages and operate directly over the pistons. The metal employed for the cylinder covers is a steel mixture of cast iron, incorporating cold-blast charcoal iron melted in a rotary furnace. Each cylinder has its own fuel pump, and the fuel valves are of the spring-loaded needle type. The fuel valve casing and seating is so designed that the cooling water is brought close to the seating and extends around the body of the atomiser, thereby ensuring a reasonable temperature for the fuel needle valve. There is a centrifugal governor of the crank shaft pattern, and a new feature which is specially useful for engines driving air compressors is the provision of a variable-range governor for controlling from half to full engine speed. Pressure lubrication is employed throughout. The lubricating pump is of the gear type, and is driven from the crank shaft by means of a chain. The engine is started on compressed air. Although a totally enclosed engine, special attention has been paid to the inspection covers, and doors, which give easy access to all working parts. They are of light weight and can be removed by one man. The range of engines represented by this example includes multi-cylinder units with five, seven, and eight cylinders, and, in addition, similar engines of the "B A" series provide a range from 240 up to 840 B.H.P.

Among the engines which are shown in operation we have specially chosen for mention the 120 B.H.P., six-cylinder vertical engine running at 800 r.p.m., which is illustrated in Fig. 27 on page viii. It differs in construction from that previously referred to, in that the valves are horizontally disposed in the cylinder heads, the air inlet valve being carried in a renewable cage, while the exhaust valve operates in a renewable guide, which is lubricated. The general construction of the cylinder head and the valve arrangement is illustrated in Fig. 18, which shows the valves of one of the smaller-powered engines, two of which will be shown in operation. In the case of the 120 B.H.P. engine, illustrated on page viii, a Bendix drive is used for starting, utilising the power from a small auxiliary engine through a belt drive. As an alternative a small compressed air motor may be employed.

The water circulating pumps and auxiliary bilge and deck-washing pumps are run at quarter engine speed, and are furnished when necessary with a disengaging clutch. The hand wheel shown at the end of the engine remote from the fly-wheel is for priming the lubricating oil system, and alongside it is an oil-pressure control valve. The air inlet manifold carries an air filter, and from it the air is delivered directly into the valve casing. Both the air and exhaust valve casings have removable covers. The engine is shown with an oil-operated reverse reduction gear-box, the standard reductions being 2 to 1 and $4\frac{1}{2}$ to 1. The clutch is furnished with operating and lubricating oil under pressure by a small gear-wheel type pump driven from the engine, and the manœuvring operation can be carried out by the finger light movement of the control cock, which can be arranged for remote control if desired.

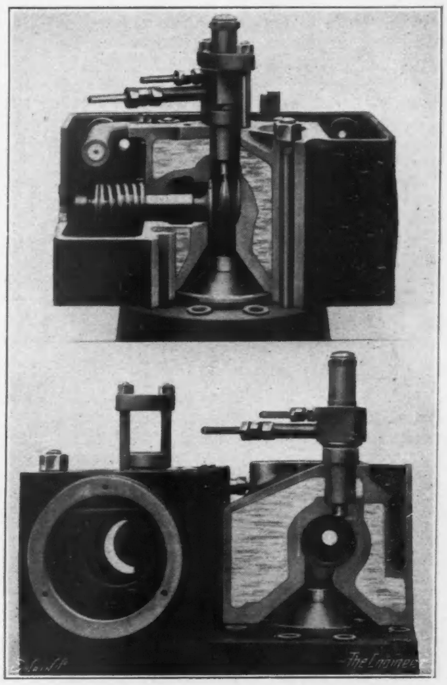


FIG. 18—CYLINDER HEAD AND VALVES—NATIONAL

In Fig. 17 we show a four-cylinder engine, one of two small marine oil engines also exhibited in operation, one of which has an output of 37 to 40 B.H.P. at 1000 to 1200 r.p.m., and the other, which is a two-cylinder unit of the same type, an output of $18\frac{1}{2}$ to 20 B.H.P. at the same speed. The four-cylinder engine is equipped with a patented spring starting device, which reduces any strain in starting up by hand. The engines we have referred to have shown good service at sea, especially in the fishing industry, and they are also being applied for lighting and auxiliary pumping on the Iraq petroleum pipe line installation.

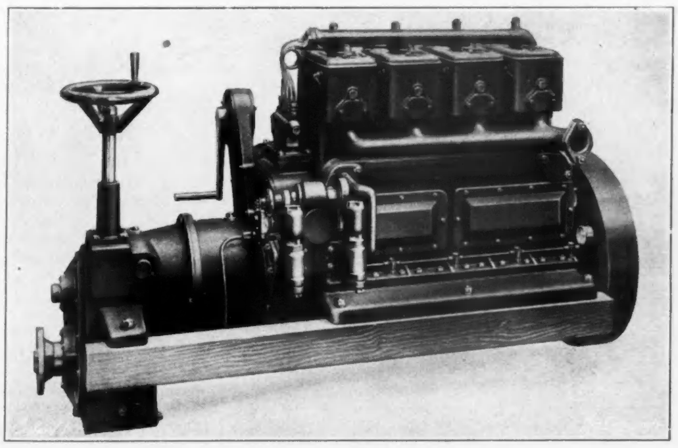


FIG. 17—37-40 B.H.P. MARINE OIL ENGINE—NATIONAL

THE ATLANTIC ENGINE COMPANY (1920), LTD.

The exhibit of the Atlantic Engine Company (1920), Ltd., of Wishaw, Scotland, comprises two examples of the company's high-speed oil engines, which are manufactured for marine propulsion, auxiliary lighting services, and for industrial driving.

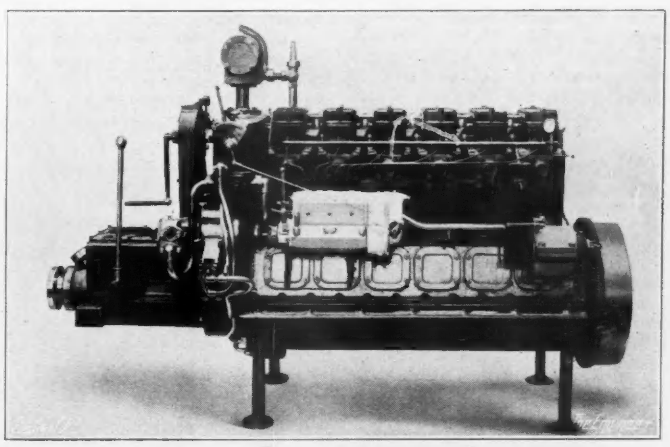


FIG. 19—55 B.H.P. MARINE OIL ENGINE—ATLANTIC

Both examples at Olympia are of the marine pattern, and are complete with plate clutch reverse gears of the company's own design. They are further arranged to illustrate three methods of starting, by electric starting motor, by air, or by hand. The accompanying illustration—Fig. 19—shows a six-cylinder engine which has a cylinder bore of 4½in. and 6in. stroke, and a designed output of 55 B.H.P. at 1000 r.p.m. The cylinders are of mono-block construction, and are made of a special close-grained cast iron. The liners are of centrifugal cast metal and are hardened. Drop forgings of high tensile steel are utilised for the connecting-rods, and the steel crank shaft corresponds to Lloyd's special requirements. In the case of the model we illustrate, both hand and electric starting is fitted. Two batteries of high power are used, which are designed also to meet the lighting services of the vessel in which the engine is installed. The other engine, a view of which is reproduced in Fig. 35 on page ix, is a four-cylinder, 70 B.H.P. unit, running at 800 r.p.m., with cylinders 6in. bore and a stroke of 8in. It is equipped with a compressed air motor starting arrangement geared to the flywheel, the air being carried in a receiver designed to have ample capacity for twelve starts. These engines represent types which have seen considerable service both at sea and on land, and have shown, we learn, a high degree of reliability in every respect.

The company also manufactures engines using petrol and paraffin fuels having a range of 5 up to 150 B.H.P. Many of these sets have been supplied for motor lifeboats and emergency lighting sets. The heavy-oil engines above referred to are built in standard units ranging from 24 up to 150 B.H.P.

ELLIOTT BROS. (LONDON), LTD.

Electrical and mechanical measuring and testing apparatus, of the indicating and recording types, for use in various industries is exhibited by Elliott Brothers (London), Ltd., of Century Works, Lewisham, S.E.13. The Siemens programme transmitter shown in Fig. 20 is used in conjunction with an automatic regulator and enables a definite and predetermined programme of operation to be followed in connection with manufacturing processes. If it is necessary, for example, that the temperature of a furnace shall first rise, then remain constant for a definite period, and finally drop at the end of the process, the apparatus may be employed to meet these conditions. It has been used for the control of annealing and carburising furnaces in the steel industry, for control in connection with drying and firing ceramics and porcelains, the treatment of cellulose in celluloid, and vulcanisation in the preparation of rubber. The mechanism, which controls the regulator electrically, consists of a number of cams cut in accordance with the required programmes and driven by a clock or an A.C. synchronous motor.

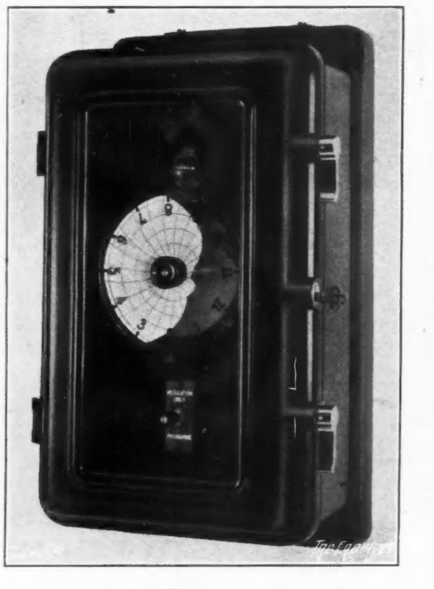


FIG. 20—PROGRAMME TRANSMITTER—ELLIOTT

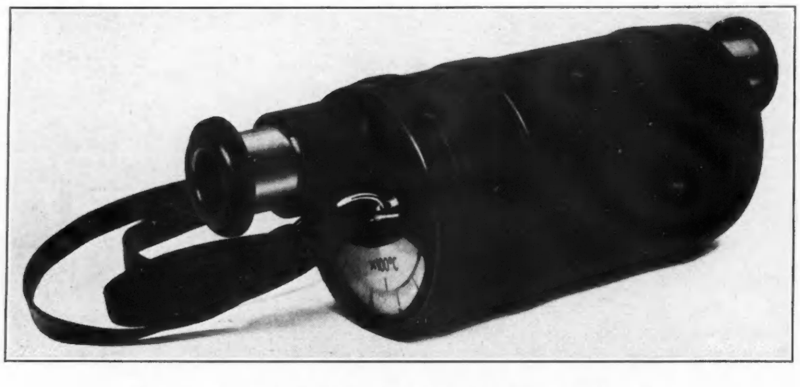
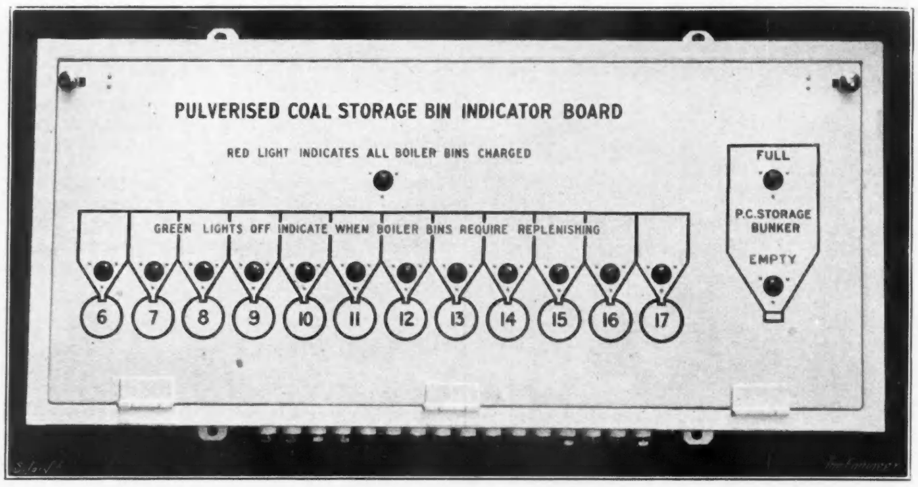


FIG. 21—OPTICAL DIRECT-READING PYROMETER—ELLIOTT

The Tollemache bin level indicator shown in Fig. 22 is used for indicating the level of the contents of a bin or bunker containing powdered or granulous substances. The instrument, which is only one of its kind, has been primarily designed for use with pulverised coal, but it can be employed to show the level in storage bins or bunkers of practically any powdered or granulous substance, such as chocolate, cement, grain, flour, or small coal or coke. The transmitter operates in conjunction with a signalling unit with a coloured lamp or lamps or a Klaxon horn, and may be part of the transmitter or a separate unit, placed in any convenient position. The pressure produced in the bin or hopper operates on a spring-loaded diaphragm attached to a plunger, the movement of which opens or closes a set of contacts which cause the signal unit to indicate when the predetermined level in the storage bins or hoppers has been reached or when they are ready for replenishing.


PULVERISED COAL STORAGE BIN INDICATOR BOARD
RED LIGHT INDICATES ALL BOILER BINS CHARGED
GREEN LIGHTS OFF INDICATE WHEN BOILER BINS REQUIRE REPLENISHING
6
7
8
9
10
11
12
13
14
15
16
17
FULL
P.C. STORAGE BUNKER
EMPTY
FIG. 22—BIN LEVEL INDICATOR—ELLIOTT

Another exhibit is a power factor finder and circuit analyser, shown diagrammatically in Fig. 23. The current coil comprises the field circuit of the wattmeter and is wound on a stator composed of iron stampings. Two moving coils rigidly connected together form a differential element, one moving coil being connected to a resistance and the other to a condenser. Across the combination a potential divider is joined, and across the terminals of this part of the apparatus the voltage of the circuit under test is applied. Assuming the power factor of the circuit is unity, then the travelling contact of the potential divider will have to be moved to point A on the potentiometer, since the current in E will then be zero and the current in D will be at 90 deg. out of phase with the flux due to the current circuit and will therefore exert no torque. The position of balance must then be at point A. For any other power factor within the range of the instrument the contact of the potential divider is moved along to some point between A and B until a new balance is obtained. By marking against the various points of balance equivalent power factors a direct-reading scale of power factor is obtained. If in one position of the change-over switch balance cannot be secured the switch should be reversed. If the power factor under test is beyond the range of the instrument balance is unobtainable with the switch in either position. In analysing the power factor of a three-phase circuit the power factor of each phase is measured in turn, and by noting the current the vector relationship can be laid out. If, at the same time, the voltage is noted, then the kilowatts can also be obtained.

The instrument shown in Fig. 21 is a new type of optical direct-reading pyrometer self-contained in a small portable case. It is known as the Siemens cross-filament pyrometer, and the principle involved is that of maintaining the filament of an electric lamp at a known constant temperature and reducing the incoming radiation of the hot body under test until the filament disappears into the background. The reduction of radiation is obtained by the interposition of a wedge-shaped graduated absorption screen calibrated in terms of temperature between the standard lamp and hot body.

The method of obtaining and maintaining the standard lamp temperature is ingenious. Actually the lamp has two filaments crossing each other and consisting of a ribbon and wire flattened at the junction point. The filaments, which are connected in series, are composed of two materials having diverse temperature-current characteristics and are supplied with current by a battery incorporated in the instrument through an adjustable resistance. The two filaments are equally brilliant at one particular temperature, which is easily obtained by adjusting the resistance. For short-duration readings the battery incorporated in the instrument is sufficient, but for longer tests a plug and socket are provided to enable an accumulator to be used. The cross filaments and observed object can be sharply focussed by the position of the lenses. Instruments are available for temperatures of 800–1500 deg. Cent. and 900–1800 deg. Cent. As none of the parts are in actual contact with the furnace, deterioration is eliminated. Other exhibits consist of a frequency recorder, speed indicators and recorders, current transformers, &c.

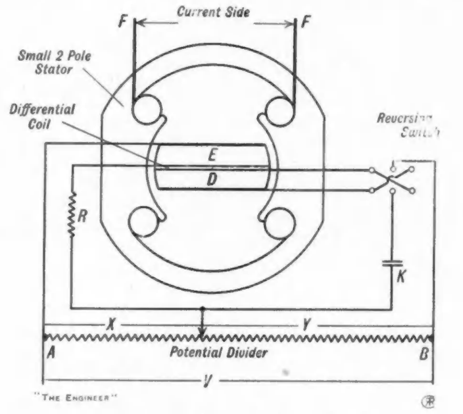


FIG. 23—POWER FACTOR FINDER—ELLIOTT

HANCOCK AND CO. (ENGINEERS), LTD.

It must have become almost a habit among engineers interested in flame cutting machines to go straight past other stands in the Exhibition to that taken by Hancock and Co. (Engineers), Ltd., of Croydon, for almost without fail some new machine or other device is to be seen here at each biennial exhibition. This year two devices are attractive. Firstly, there is the improved type of machine known as the "Simplex" universal, which we illustrate in Fig. 24; and secondly, there is the portable "Auto" cutting machine. To take the "Simplex" model first, unlike the U arm type, this machine has the work piece on one side of the centre and the template or drawing table on the other. The tracer head is fixed to a carriage upon which is also mounted the burner on an extended arm. This carriage is able to run for the full width of the machine on two tubes, which, being mounted on wheels at each end, are able to move back and forth on rails. To keep the tubes in axial alignment coupled pinions at each end engage with racks in the rails. Automatic straight line cuts, vertically or at a bevel, can be made parallel to the axes of the machine and, if required, two cutter heads can be fitted to allow dual regular or irregular cutting to be carried out from one template or drawing. In addition, circles may also be cut automatically. In conjunction with the universal tracer head a reversible table makes it possible to change over from template to drawing operation in a few seconds. The tracer head has three interchangeable forms of drive: directly from a drawing; from a template of strip aluminium; or from a wooden template. All the controls for the gas, heating, and cutting oxygen, starting and stopping and reversing the motor, and vertical adjustment of the burner can be operated from either the front or the back of the machine, while the cutting speed in inches per minute is shown by a speed indicator mounted on the tracer head.

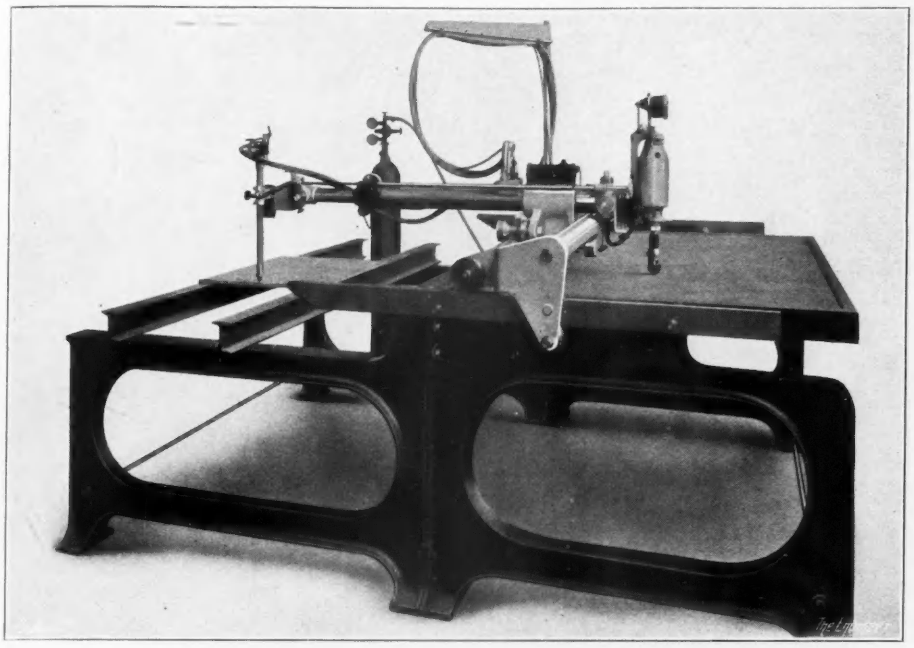


FIG. 24—"SIMPLEX" UNIVERSAL CUTTING MACHINE—HANCOCK

The other machine to which we have referred is illustrated in Fig. 25. It is particularly suitable for shipyard work and the like and is shown for the first time. For straight cutting the machine is fitted with two spring guide wheels which normally engage with a 1½in. angle guide or similar device. Bevels up to 35 deg. may be cut by swivelling the head. Additional usefulness is given to the device by the provision of a radius bar, which may be fitted on either side. The machine may thus be made to rotate round a centre held in position by means of a spring-operated centre point. Circles from 2in. radius upwards may be cut. As will be seen from the drawing, the driving motor is enclosed within the main body. It can, however, easily be removed, and since it is connected up by means of plugs and sockets, no electrical connections need be disturbed by the operation. If required, the direction of rotation of the motor may be reversed. From the motor the drive is taken through worm and worm wheel reduction gearing to the front shaft to drive directly the wheel nearest the burner. In order to obviate the disadvantage of driving both wheels directly, an arrangement which would cause the machine to have a tendency to run straight when hand guided, a friction device is placed between the driving shaft and the other wheel. This clutch may be adjusted to be free, partially locked, or completely locked. Thus when the machine is hand steered, slip at the clutch occurs when rounding curves. A copper-asbestos shield protects the nearer driving wheel from sparks emanating from the burner. Control is effected from a grip handle. The first grip opens the heating oxygen and the second starts the motor and turns on the cutting oxygen. A dial in the top of the box-shaped aluminium body records the travelling speed in inches per minute. As will be seen from notes on the drawing, the burner has a 1½in. transverse movement on the slide and the height of the burner from the plate may be adjusted.

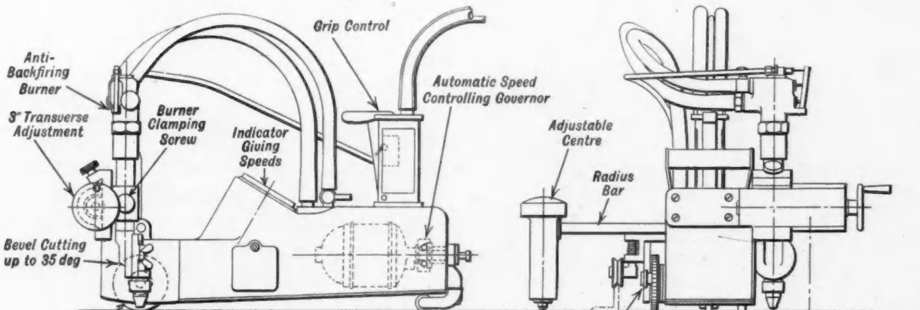


FIG. 25—PORTABLE "AUTO" CUTTING MACHINE—HANCOCK

THE TURBINE FURNACE COMPANY, LTD.

In bringing to our notice its exhibit at Olympia the Turbine Furnace Company, Ltd., of 238B, Gray's Inn-road, London, states that every job with which the firm comes into contact in this country requires special consideration of the various factors involved. For instance, at collieries and works situated near collieries a type of furnace such as the steam jet forced draught with extension grate, suitable for burning the low-grade fuel with high ash content cheaply available in such districts is called for, whereas it is futile to transport such a high proportion of ash to centres far removed from collieries, and a furnace suitable for the use of good or washed fuel is then required. In the firm's experience fan forced draught, either with hand or mechanical stoking, can on ordinary standard boilers be expected to give an all-round efficiency of 70 per cent. The firm's exhibit is a full-size Lancashire boiler front. The left-hand flue is fitted with a furnace and extension grate arranged for machine firing by sprinkler stoker and fan forced draught; and the right-hand flue has a standard furnace arranged to suit a marine boiler with steam jet forced draught. The line engraving reproduced in Fig. 26, although actually referring to an installation on the s.s. "Cormorant," is exactly the same in all particulars as that shown at the Exhibition. The fire-bars have forwardly inclined blades, which deflect the air through the air spaces with the minimum of resistance and, together with the diminishing cross-sectional area of the troughs, reduce the amount of steam or power required for forced draught. For a typical Lancashire boiler evaporating between 9000 lb. and 10,000 lb. per hour a figure of 2 H.P. is given by the makers for this service. According to figures the makers have obtained as a result of six months' working on a number of small steamers, the tonnage of low-grade fuel burned in the furnaces supplied is no greater than that of better quality fuel consumed on ordinary bars under natural draught conditions.

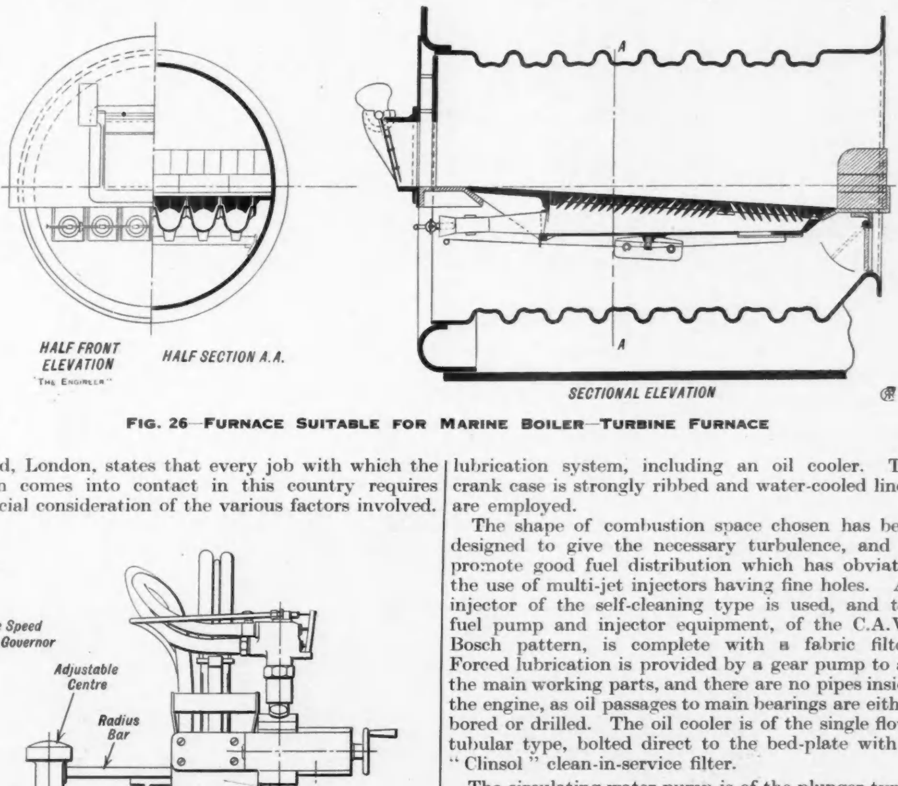


FIG. 26—FURNACE SUITABLE FOR MARINE BOILER—TURBINE FURNACE

J. SAMUEL WHITE AND CO., LTD.

Oil-firing equipment for boilers and furnaces on the mechanical jet pressure system forms the principal exhibit on the stand of J. Samuel White and Co., Ltd., of Cowes, Isle of Wight. The main exhibit is a pressure oil pump and heater, with suction and discharge strainers, complete with a hand pump for lighting purposes, the whole equipment being designed for use with furnace fronts, fitted with pressure-type oil burners. Various patterns of furnace fronts are illustrated.

The type of burner used is, it is claimed, specially useful for lighting up purposes, as it will burn cold oil. An interesting type of burner carrier is also shown, which enables burners to be quickly withdrawn and replaced; a safety hook cutting off the oil supply before the burner can be taken out.

The firm is also showing a four-cylinder, cold-starting marine type oil engine working on the compression-ignition principle, which is complete with reverse gear. It is illustrated in Fig. 30 on page viii. It is rated at 24 B.H.P., 1000 r.p.m., and has a fuel consumption of 0·45 lb. per B.H.P.-hour. It is totally enclosed and works with a pressure-feed lubrication system, including an oil cooler. The crank case is strongly ribbed and water-cooled liners are employed.

The shape of combustion space chosen has been designed to give the necessary turbulence, and to promote good fuel distribution which has obviated the use of multi-jet injectors having fine holes. An injector of the self-cleaning type is used, and the fuel pump and injector equipment, of the C.A.V.-Bosch pattern, is complete with a fabric filter. Forced lubrication is provided by a gear pump to all the main working parts, and there are no pipes inside the engine, as oil passages to main bearings are either bored or drilled. The oil cooler is of the single flow, tubular type, bolted direct to the bed-plate with a "Clinsol" clean-in-service filter.

The circulating water pump is of the plunger type, and is mounted on the crank case, but is so arranged as to prevent any water from contaminating the lubricating oil. Starting is effected by hand with the aid of a tinder cartridge or electric plugs.

The reversing gear incorporates ahead and astern multi-plate clutches, and is mounted upon an extension of the engine bed-plate and crank case. It is of the epicyclic spur wheel type, with pinions running in self-aligning ball bearings. Heat-treated steel is employed for the gearing, and the use of ball bearings has reduced the number of bushes to a minimum. The gear is fully lubricated from a passage in the crank shaft, which is fed from the main pressure oil supply. Models and photographs of vessels constructed by the firm, including naval, commercial, and pleasure craft, are also shown.

MARINE OIL ENGINES EXHIBITED AT OLYMPIA

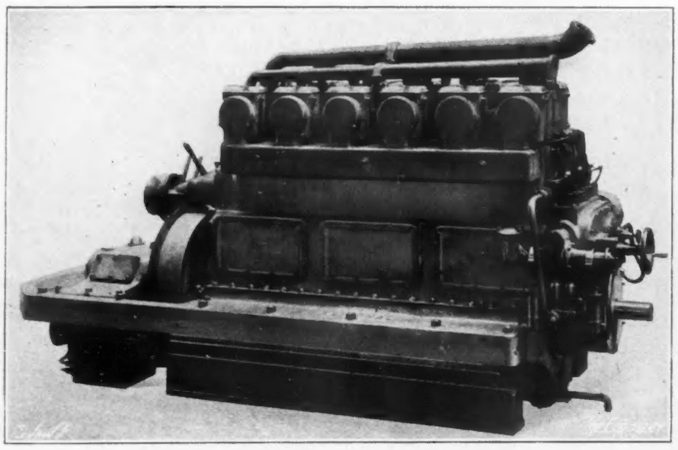


FIG. 27—120 B.H.P. SIX-CYLINDER MARINE ENGINE—NATIONAL

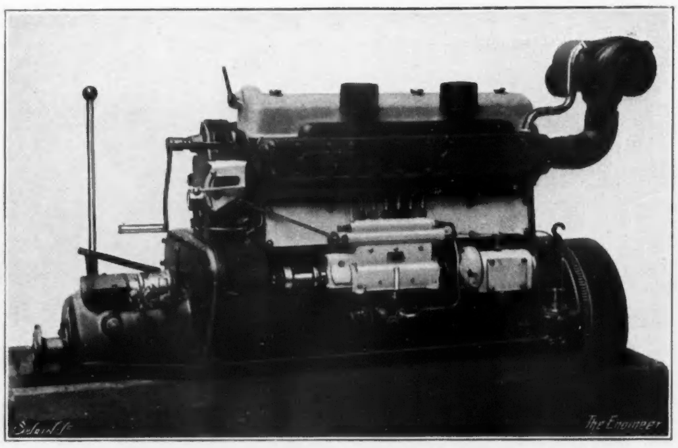


FIG. 28—50-65 B.H.P. MARINE ENGINE—THORNYCROFT

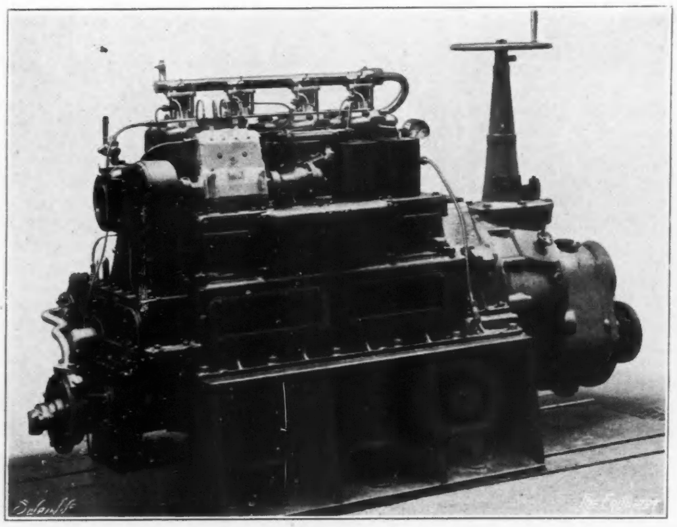


FIG. 29—40 B.H.P. FOUR-CYLINDER MARINE ENGINE—PETTERS

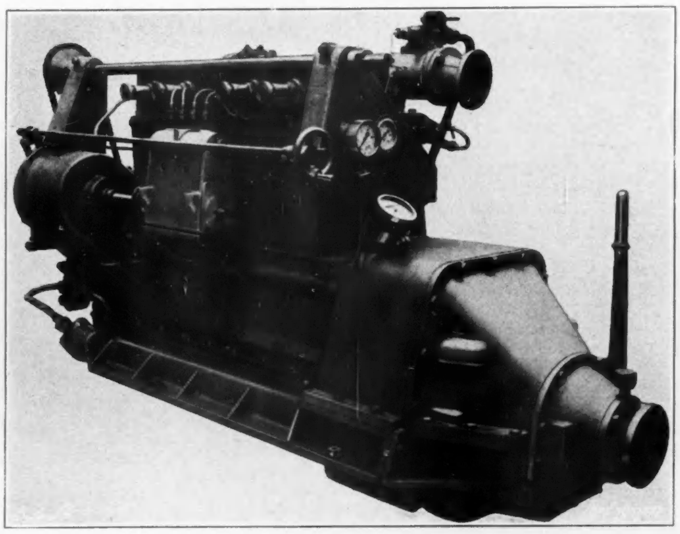


FIG. 30—24 B.H.P. FOUR-CYLINDER MARINE ENGINE—SAMUEL WHITE

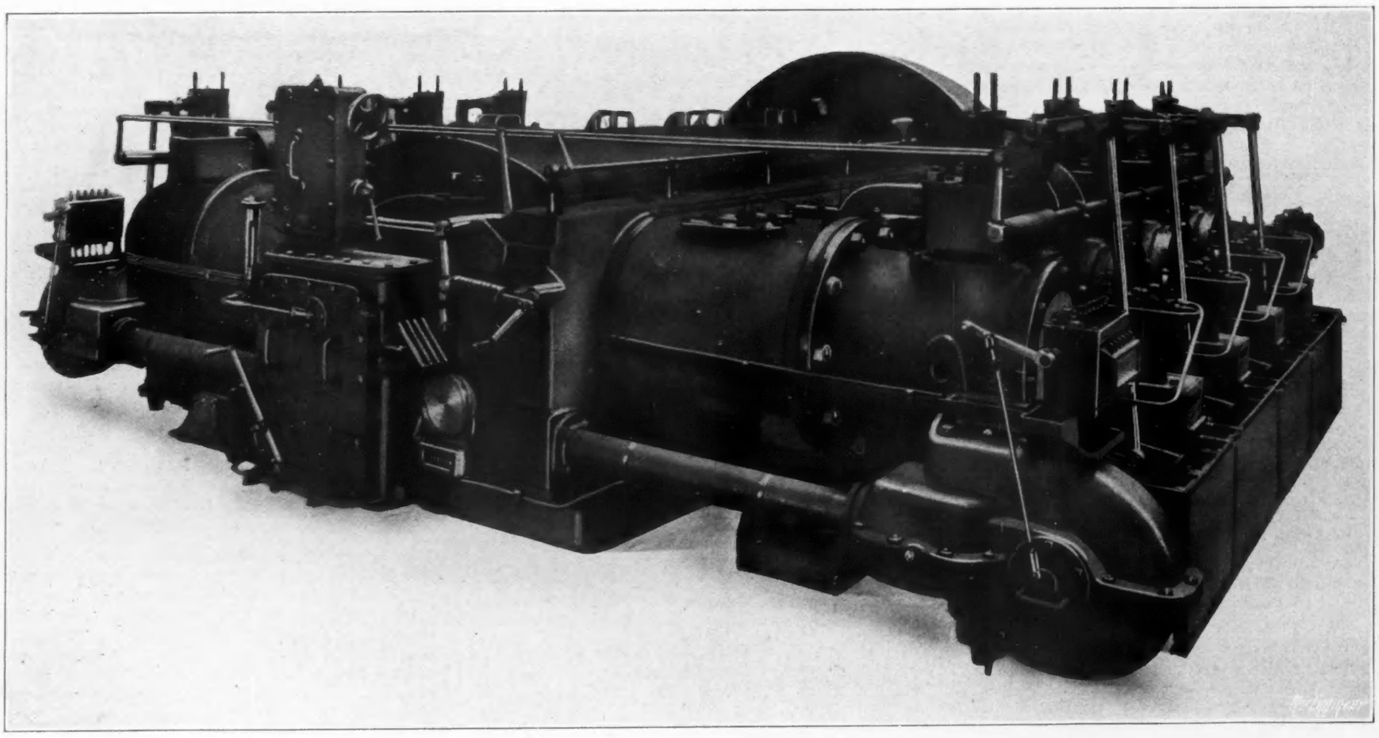


FIG. 31—600 B.H.P. VIS-A-VIS FOUR-CRANK MARINE ENGINE FOR ELECTRIC PROPULSION—PREMIER

MARINE OIL ENGINES EXHIBITED AT OLYMPIA

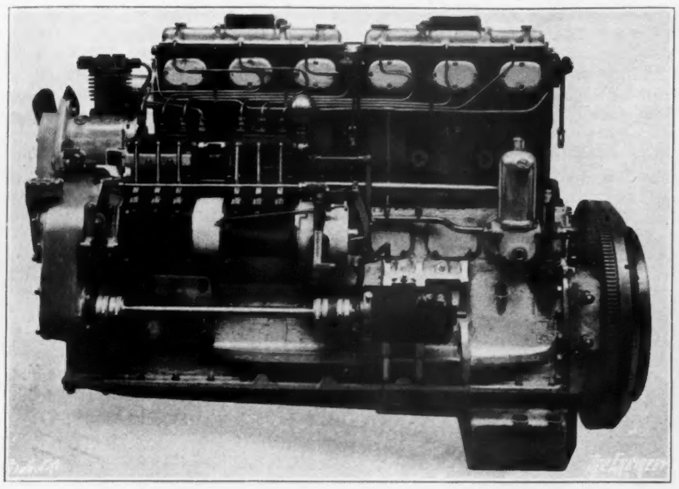


FIG. 32—102 B.H.P. SIX-CYLINDER MARINE ENGINE—GARDNER

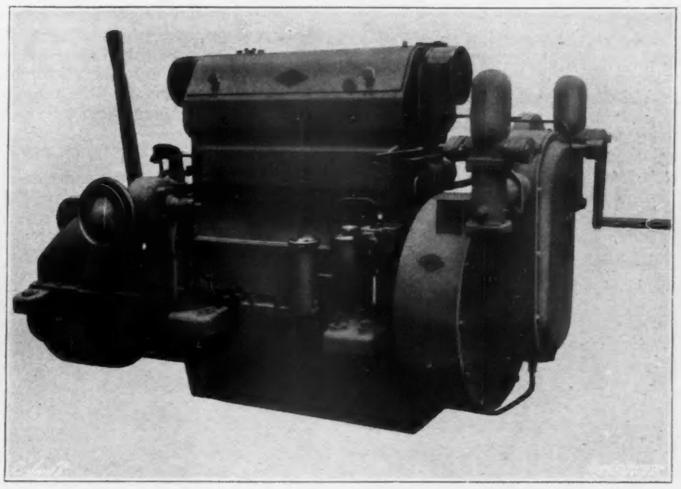


FIG. 33—40 B.H.P. FOUR-CYLINDER MARINE ENGINE—BLACKSTONE

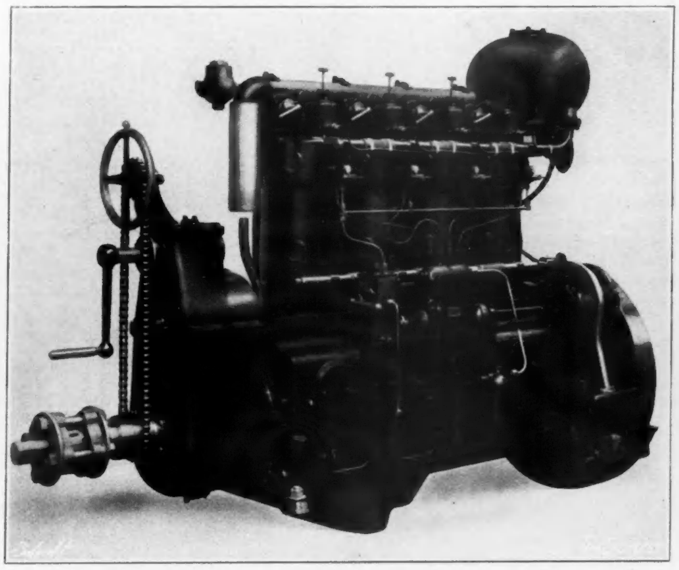


FIG. 34—88 H.P. FOUR-CYLINDER "KELVIN-DIESEL" ENGINE—BERGIUS

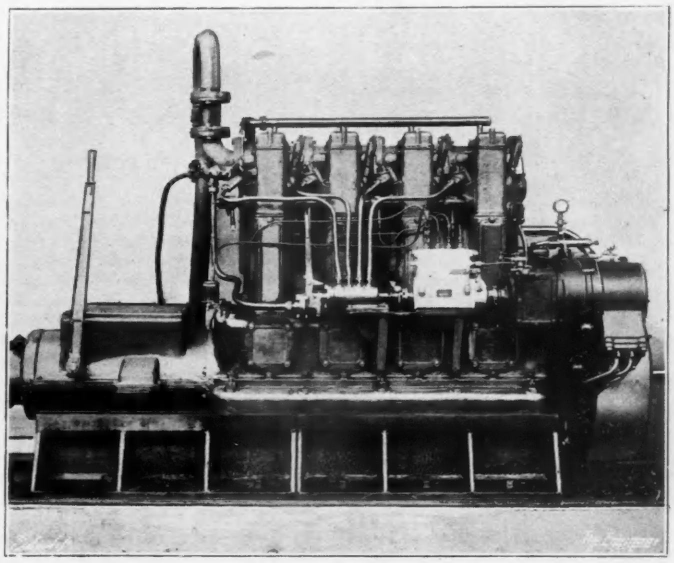


FIG. 35—70 B.H.P. HIGH-SPEED ENGINE—ATLANTIC

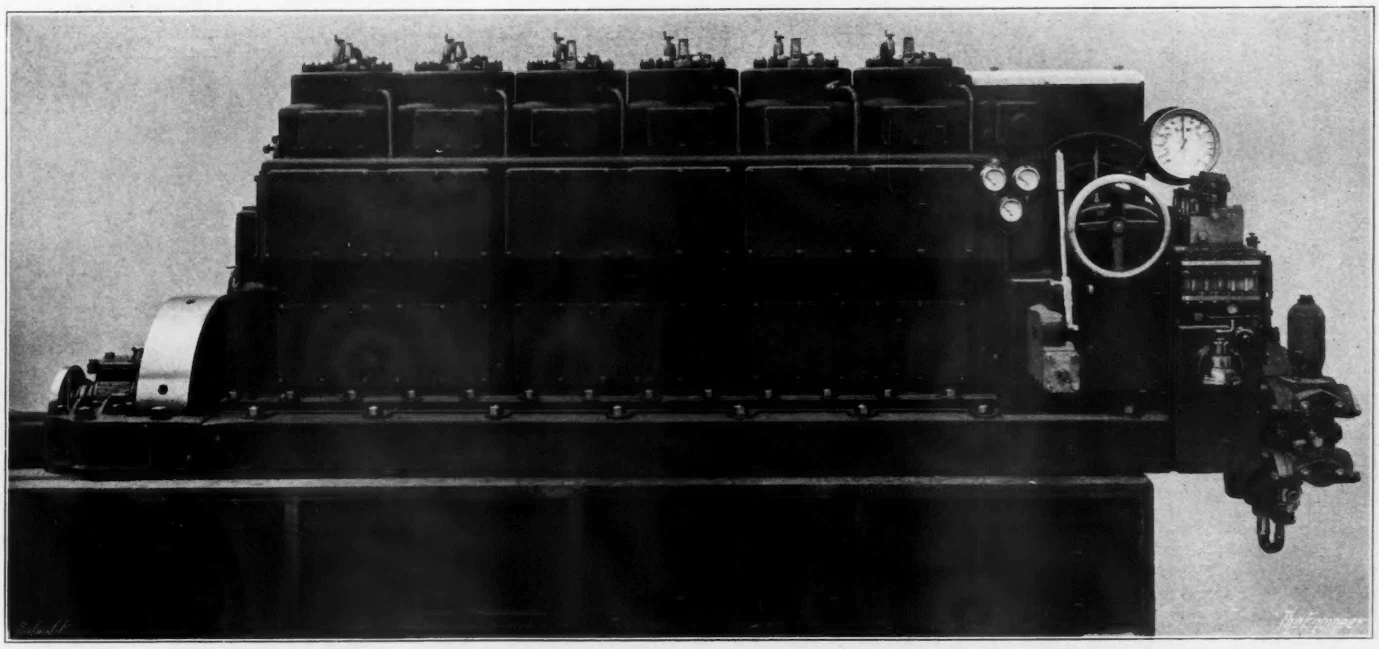


FIG. 36—SIX-CYLINDER 150 B.H.P. MARINE ENGINE—CROSSLEY

Negretti and Zambra.

As usual, upon the stand taken by Negretti and Zambra, of Holborn-viaduct, London, there are exhibited various instruments for a very wide range of purposes. The number of different instruments manufactured by this firm is indeed almost bewildering in its variety, although the number of principles on which they are all built is comparatively small. Out of such a display it is a matter of some difficulty to make a choice. Prominent, of course, is the mercury in steel dial thermometers, well known to many besides actual users of the firm's products. These instruments are suitable for a very wide range of temperatures, and it is claimed that the direct-action movement and the "micro-bore" capillary construction, together with other devices, eliminates or renders negligible all errors due to friction, back-lash, hysterisis, barometer variation, bulb level, and vibration. In view of the widespread knowledge of their construction, a description of a typical instrument is not called for. Operating on the same principle, however, the firm has recently produced the "Mersteel" recording thermometer, illustrated in Fig. 38. It has been designed to give at a lower price an accuracy and reliability comparable with older designs. It takes a chart 9½in. in diameter and has a pen travel of 4in. The chart may be graduated to any standard range, and may be suitable for daily or weekly records. A moisture and fume-proof cast iron case carries the rustproof movement within. As may be noted from the engraving, the instrument can be supplied with two pens if desired.

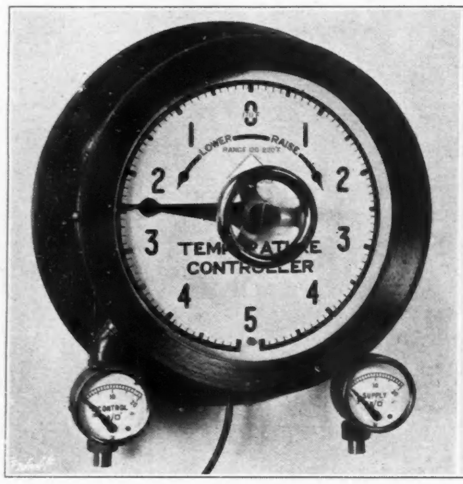


Fig. 37—Temperature Controller—Negretti

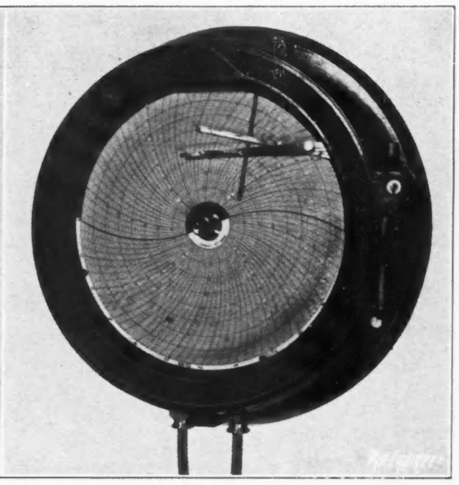


Fig. 38—Recording Thermometer—Negretti

Space precludes any lengthy mention of many of the other exhibits shown on the stand. Numbers of electrical thermometers, recording thermo-couple pyrometers, humidity controllers, and boiler-house instruments are to be seen in various mountings. One of the most interesting devices is the temperature controller illustrated in Fig. 37. The principle on which it acts is shown diagrammatically in Fig. 39. Main control is obtained from a mercury-in-steel thermometer, the movements of which, however, are not directly concerned in altering the supply of fuel to the heating burner. For this purpose compressed air at a pressure of 15 lb. per square inch is utilised. Each controller requires about 0·5 cubic feet per minute for its satisfactory operation. Referring to Fig. 39, the main fuel supply pipe is shown at the bottom and the temperature controller E at the top. The compressed air is admitted to the pipe J through a restriction valve C. Should the temperature to be controlled vary, the bourdon element H of the thermometer, of which the bulb is shown at G, alters its position, thereby altering the setting of a leak valve E and causing the air pressure in the pipe line J to rise or fall. This air pressure acts upon the diaphragm which controls the opening of a valve in the fuel supply pipe, and its alteration thereby causes a change in the rate of supply of the fuel. Since the leak valve E can be adjusted to give a fine throttling action, periodic peaks of temperature are avoided. Two air pressure gauges are fitted to the instrument showing respectively the inlet pressure and the pressure in the pipe line J. Besides those mentioned, many other instruments are to be seen on the stand.

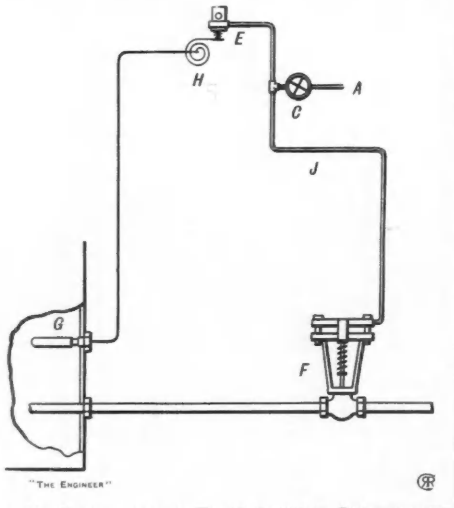


Fig. 39—Operation of Temperature Controller

The Stream-Line Filter Company, Ltd.

Upon the stand taken by the Stream-Line Filter Company, Ltd., of 45, Horseferry-road, London, there is a very interesting portable filter set similar to that illustrated in Fig. 41. Another of the same type is mounted on castors. These portable sets are intended for filtering, de-hydrating, and de-aerating the insulating oil of transformers and other electrical equipment, and the arrangement of the various parts within the plate metal casing mounted on the trolley is shown diagrammatically in Fig. 40. Two cocks, suitable for the reception of hoses, are mounted on one side of the outfit, and provide for the inlet of dirty and the outlet of cleaned oil respectively. From the inlet cock the dirty oil is admitted to a chamber containing an electric heater. This latter is provided with tubular immersion elements of ample capacity controlled by triple-pole switches in groups of three, and serves to raise the oil to a temperature of 60 deg. to 80 deg. Cent. From the heating chamber the oil is drawn by an oil pump, which delivers at a steady rate into the filter chamber. As engineers will be well aware, the filter made by the Stream-Line Filter Company employs the principle of edge filtration between paper discs mounted on rods and maintained under suitable compression by end loading. When liquid is forced between the papers from the outside to the inside, all traces of solid and even colloidal carbon from switches, it is claimed, are retained at the edges, so that the liquid, in this case oil, passes onward absolutely clean. The solids, of course, build up as a cake on the outside of the filter columns, and are easily removed by reversal of pressure as will be described later. As the papers are cleaned without removal, the same packs last for many years. The possibility that loose fibres might be carried forward by the oil is removed by a suitable "running in" period in the manufacturer's works. Having passed through the filter, the now clean oil enters a vacuum chamber. Here it falls over a series of shallow trays dripping down from one to the next. A certain degree of moisture has already been removed from the oil in passing through the filter in layers of molecular dimensions. In the vacuum chamber the temperature of the oil is well above the boiling point of water, corresponding to the vacuum, and consequently the last traces of moisture are removed. Together with air and gases also removed from the oil, owing to the low pressure, the moisture is drawn out of the top of the receiver by a dry pump of the vacuum type. The cleaned and renovated oil, meanwhile, is withdrawn from the bottom of the chamber by a special pump, the rate of delivery of which is controlled by a float valve in order to maintain an adequate level of oil in the chamber. Although shown separated in the diagram, the two oil pumps and the vacuum pump are all mounted together on a convenient bed-plate and driven by a single motor. The plant, it will be seen, can be operated continuously, and having cleaned, dried, and de-aerated the oil, delivers it without exposure to the atmosphere to whatever place it may be required. It remains to be described how the pressure is reversed for cleaning the filter columns. It will be noticed in the diagram that there are four three-way cocks controlling the flow at various points. It should also be noted that the vacuum pump is adaptable to work as a compressor. Before shutting down the plant after a spell of work, the position of the cock A is reversed, so that the atmosphere is put into connection, not only with the interior of the vacuum receiver, but also with the suction side of the vacuum pump. At the same time the air delivered by the vacuum pump cannot escape from the air bottle, since the passage through cock A is now blocked. Consequently, an air pressure is built up. Concurrently, the filter chamber is drained of unfiltered oil by turning cock B to open it to atmosphere, the connection with the vacuum chamber being by the same operation broken. So soon as sufficient pressure has been built up in the air bottle, the cock C is turned to interconnect the air bottle with the discharge side of the filter chamber. As a result, air is blown through the filter in the reverse direction, and the cake of solids is thereby removed to drain with the remnant of the unfiltered oil as a sludge out of the chamber. Cock D, which has so far remained unmentioned, is made use of when starting up to re-circulate the oil in the heating chamber until a sufficient degree of temperature has been attained for the plant to be put on continuous operation.

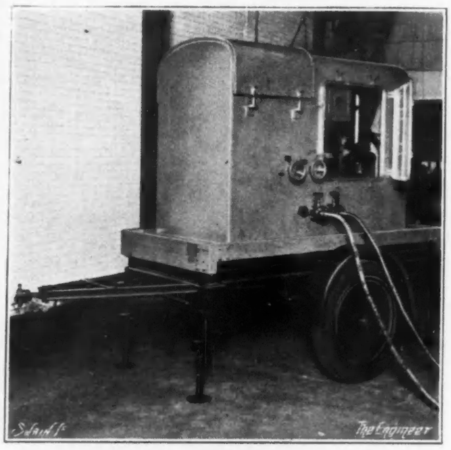


Fig. 41—Portable Filter—Stream-Line

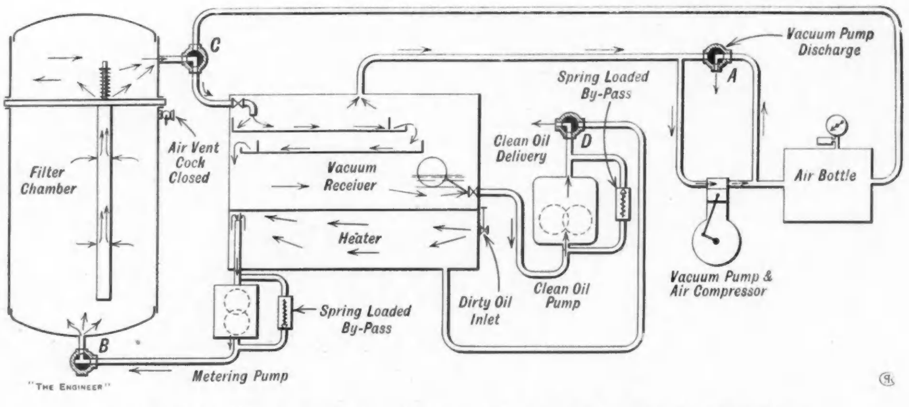


Fig. 40—Diagrammatic Arrangement of Portable Filter—Stream-Line

Besides the plant just described, the firm is on this occasion making a special exhibit of devices for direct attachment to engine lubricating systems, as distinct from the self-contained type, which deals with batches of oil quite apart from the engine. Some time ago a distinct preference was shown for the latter arrangement, but we are informed by the makers that there has been a gradual growth of favour for the attachment type of recent years.

A range of six such plants suitable for engines of 50 to 1500 B.H.P., and capable of by-passing 2 per cent. of the oil in circulation per hour, is therefore being shown.

W. KENNEDY.

Tube and bar bending machines in several sizes and types are exhibited by W. Kennedy, of West Drayton, Middlesex, and we have chosen for illustration in Fig. 42 one of the smaller machines utilising direct leverage. It is suitable for bending, cold and unloaded, wrought iron gas, steam and water tubing up to 1in. bore. With suitable formers brass, copper, and steel light-gauge tubing may also be bent, while work upon angles, tees, channels, &c., is within its capacity if special formers are provided. The principle of operation is very simple. Upon the main body or base there is screwed an adjustable top plate. One of the former rings is placed between the top plate and the base and the tube is bent around it by the use of a lever placed in one of the holes provided in the bending arm. Instead of a bending block a suitably shaped roller is used. Owing to the tendency of the work to expand laterally when being bent, the top plate becomes tightly fixed. In order to unscrew it, therefore, the bending arm is swung back until the pin to be seen in the engraving drops into one of the holes in the plate. The full leverage of the arm may then be used to loosen it. Larger machines made by the firm utilise a gear and ratchet principle to increase the leverage available. Machines suitable for bending still heavier material are operated through a worm and wheel mechanism.

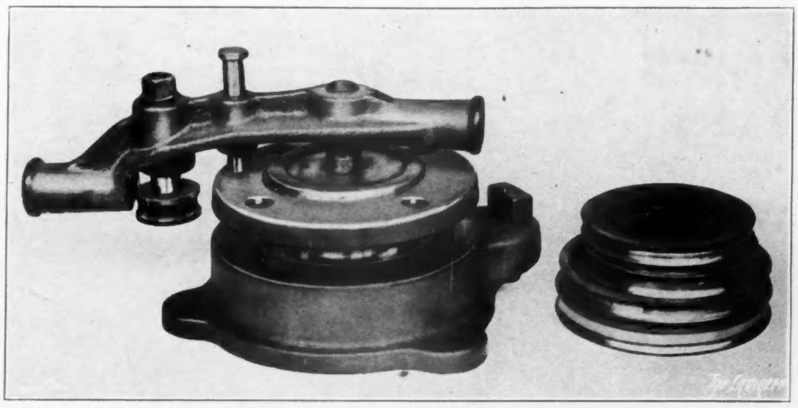


FIG. 42—TUBE BENDING MACHINE AND FORMERS—KENNEDY

J. G. SMITHSON AND CO., LTD.

Industrial motor controllers of the contactor type with new mechanically operated contactors are being exhibited in sizes ranging from 5 to 100 horsepower and suitable for A.C. or D.C. supplies by J. G. Smithson and Co., Ltd., of Nelson House, Moorstreet, Birmingham 5. The contactors are mounted on an insulated panel inside the controller, as shown in Fig. 43, and are operated by a camshaft directly coupled to the crank handle. The contacts are made of "Steb" metal, consisting of a copper base with a heavy silver face sweated and rolled in, the circuit being made and broken on the silver faces alone. Water and dust-proof cases protect the working parts and the general design complies in every way with the applicable B.S.I. specifications.

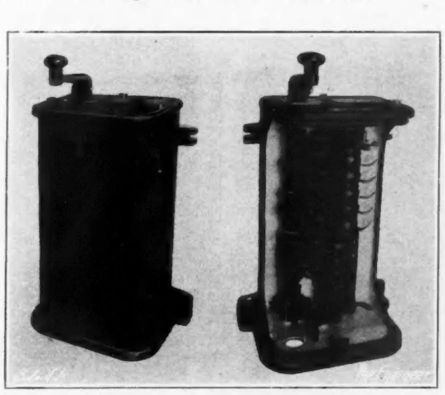


FIG. 43—INDUSTRIAL MOTOR CONTROLLER

Battery vehicle and light-weight trolley omnibus controllers are shown. The latter is a direct-acting contactor controller with eight notches for plain-series resistance or tapped field control. The contactors are trigger operated by an "over-centre" motion and are closed by means of a simple lever coupled directly to the foot pedal. As no cams or ratchets are employed, the mechanism is free from complications. Motors with capacities up to 150 horse-power at 600 volts can be controlled, the continuous rating of the trigger-operated contactors being 200 ampères. It is said to be impossible to open or close the contactors slowly even if a deliberate attempt be made to do so. Like the contacts on the industrial controllers, those on this trolley omnibus apparatus are composed of "Steb" metal and the circuit is made and broken on the silver faces.

The arc shields and blow-out coils are mounted together as single unit, which is pivoted at the top. By undoing two nuts this unit can be swung clear of the contacts, which can then easily be inspected without interfering with the connection to the blow-out coils. A separately mounted foot pedal, which can be fixed in any position convenient to the driver, serves for operating the controller, and although there is no difficulty in deciding when a notch has been passed, the pressure required to operate the apparatus is small. The total weight is only 112 lb. and the complete unit is neat and compact. A separately mounted drum type switch, electrically interlocked with the main controller, serves for reversing the motor.

THE LIVERPOOL REFRIGERATION COMPANY, LTD.

With a view to meeting the demand that is believed to exist for small horizontal oil engine-ammonia compressor sets the Liverpool Refrigeration Company, Ltd., of Colonial House, Water-street, Liverpool, together with Tangyes, Ltd., of Birmingham, has brought out the set illustrated in the accompanying engraving, Fig. 44. It is claimed that such a combination set will show a saving in fuel and initial costs over the more usual motor-driven refrigeration compressor, and that although it takes up slightly more deck space, it can be accommodated in a 'tween deck as easily. The actual capacity of the set exhibited is 20 tons refrigeration on a gas cycle of 5 deg. Fah. and 86 deg. Fah.—equivalent to 240,000 B.Th.U. per hour—and the floor space required is 8ft. by 10½ft. by a height of 4ft. 6in. The compressor is of the double-acting type with suction and delivery valves of the ring plate variety fitted in the back cover and readily accessible. Access to the cast iron piston and the interior of the cylinder is gained by the removal of the back cover, complete with its valves, and without disturbing any of the connecting piping. By altering the position of the slipper type crosshead the piston clearance can be adjusted. The compressor is driven by a single-cylinder Tangye oil engine developing 39 B.H.P. at 270 r.p.m. and coupled to the compressor through a heavy fly-wheel. The speed may be reduced to 140 r.p.m., if required, while the engine is running. The Tangye system of super-compression which we have described on previous occasions is fitted to the engine for use when starting.

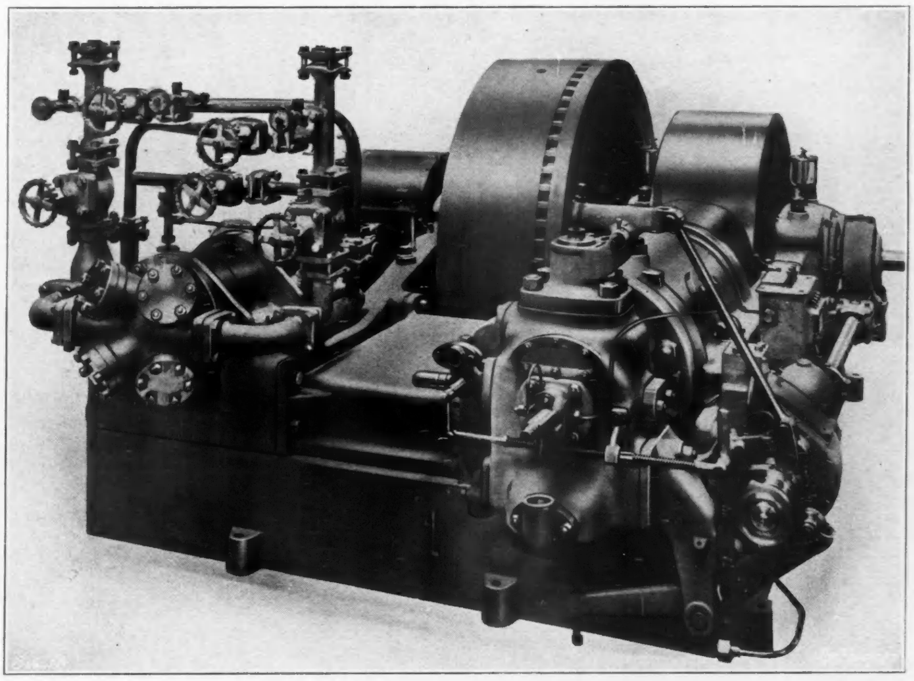


FIG. 44—HORIZONTAL OIL ENGINE - AMMONIA COMPRESSOR SET—LIVERPOOL REFRIGERATION

THE SPIRAL TUBE AND COMPONENTS COMPANY.

The Spiral Tube and Components Company, of King's Cross, London, and of Derby, has as one of its chief exhibits a combined water and oil cooler for oil-engine locomotives. Both elements are cooled by a single high-efficiency fan, which is driven at low speed by a double "V" belt. The fan spindle is provided with a belt-tensioning device. The accompanying illustration shows the back view of a cooler suitable for engines of from 200 to 250 H.P., and is representative of a range designed for engines of 100 to 600 H.P. Under normal climatic conditions it will dissipate 360,000 B.Th.U. per hour from the water, and 36,000 B.Th.U. per hour from the oil, the capacity of other sizes of coolers being in proportion. The whole of the cooling tubes and fins are made of copper in order that the efficiency may be maintained over a long period. Spiral copper fins or gills arranged to give maximum turbulence and minimum air resistance are wound on both sets of tubes, those for the oil cooler being still further provided with spiral internal baffles to promote oil turbulence. These baffles also act as oil cleaners,

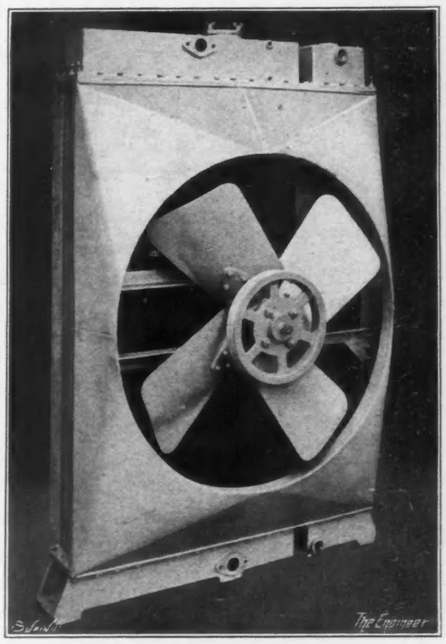


FIG. 45—COMBINED WATER AND OIL COOLER —SPIRAL TUBE

since they can be withdrawn, wiped, and replaced on removal of the top header. The fact that the guaranteed power consumption of the fan is less than 3 B.H.P., or only 1·2 per cent. of the higher engine output for which the cooler is designed, indicates the efficiency of the cooler.

Other exhibits on this stand include water coolers for internal combustion engines, Plenum type heaters for cinemas, public buildings, and for producing hot air for industrial processes up to a temperature of 370 deg. Fah.; unit heaters for garages and factories by means of which warm air is deflected to the ground level by means of electric fans; oil coolers operated by water; and copper spiral gilled cooling coils for refrigerating plants.

Crossley Brothers, Ltd., and The Premier Gas Engine Company, Ltd.

The largest working oil engine in the Exhibition is to be seen on the stand of Crossley Bros., Ltd., of Manchester. It is a Crossley-Premier horizontal *vis-à-vis* eight-cylinder four-crank marine oil engine, shown by the Premier Gas Engine Company, Ltd. (Crossley Brothers, Ltd.), of Sandiacre, near Nottingham. A view of the engine is reproduced in Fig. 31 on page viii. Its rated output is 600 B.H.P. at 300 r.p.m., or, when supercharged by an electrically driven blower, 750 to 800 B.H.P. at the same speed. The engine is of particular interest, as it is an exact duplicate of that supplied for the electrical propulsion of an electric ferry boat which has been built at the yard of the South China Motor Shipbuilding and Repairing Works, Hong-Kong, for the Star Ferry Company's Hong-Kong-Kowloon service. The normal rating of the ferry boat engine is 500 B.H.P. at 270 r.p.m., and 575 B.H.P. at 300 r.p.m. under overload conditions. It is coupled direct to a 300-kW B.T.H. generator, which delivers current to two 370 B.H.P. motors mounted on the propeller shaft, one at each end of the ship. The generator and the motors are controlled from the bridge. Drawings of this ferry boat were published in The Engineer of December 30th, 1932.

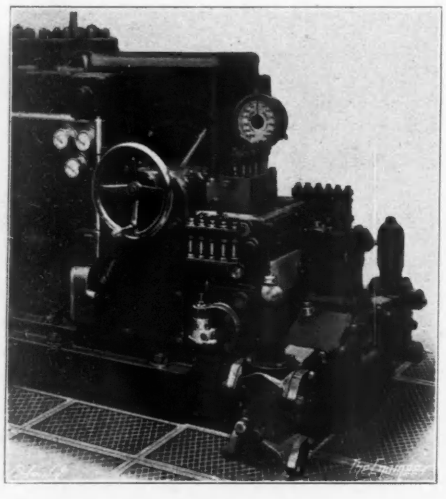


FIG. 46—CONTROL END OF 150 B.H.P. ENGINE—CROSSLEY

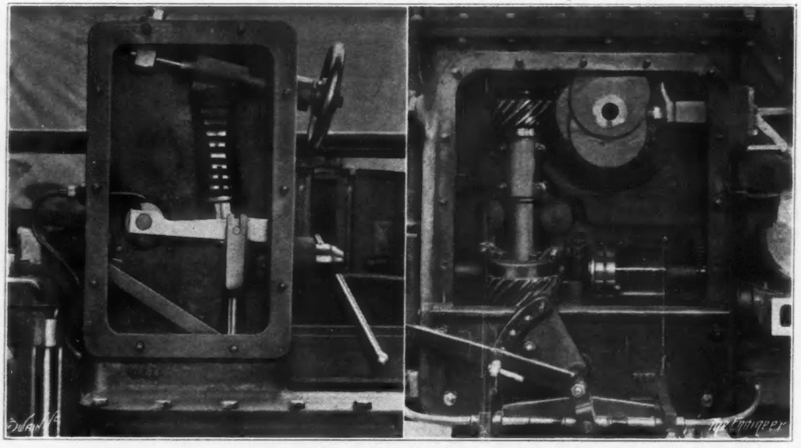


FIG. 47—SPEED ADJUSTING AND GOVERNOR GEAR—CROSSLEY

As the speed control arrangements of the engine are of particular interest we show in Fig. 47 two views, one of the governor on the side shaft and the other of the hand-operated speed adjusting gear. The governor is arranged on a vertical shaft which is driven direct from the crank shaft and is of the vertical spring-loaded type. The movement of the governor is transmitted by a side rod to a series of wedges on the fuel pumps, which by controlling the opening of the fuel pump by-pass valves regulate the fuel delivered to the cylinders in direct proportion to the load requirements. The light cams which are seen to the right of the governor spindle are for the indicating gear motion.

A Crossley engine of outstanding interest is a new six-cylinder two-stroke direct-reversing vertical marine engine with a scavenge pump mounted at the forward end of the bed-plate. It is illustrated in Fig. 36 on page ix and a view of the starting controls and auxiliary pumps is reproduced in Fig. 46 herewith. This engine is built in units of three to six cylinders and the output of the engine exhibited is 150 B.H.P. at 450 r.p.m. As will be gathered from our illustration, the whole structure is very rigid, the monobloc type crank case being bolted direct to the girder pattern base-plate, the thrust block being mounted on an extension of the bed-plate at the fly-wheel end. The cylinders are separate units and are interchangeable. Large inspection doors are provided, giving access to all running parts. The scavenge pump is operated directly from the crank shaft. As the scavenge air is delivered directly into the manifold serving all the cylinders, and a non-return valve is fitted to each cylinder, any possibility of the exhaust gases blowing back into the inlet air manifold is avoided.

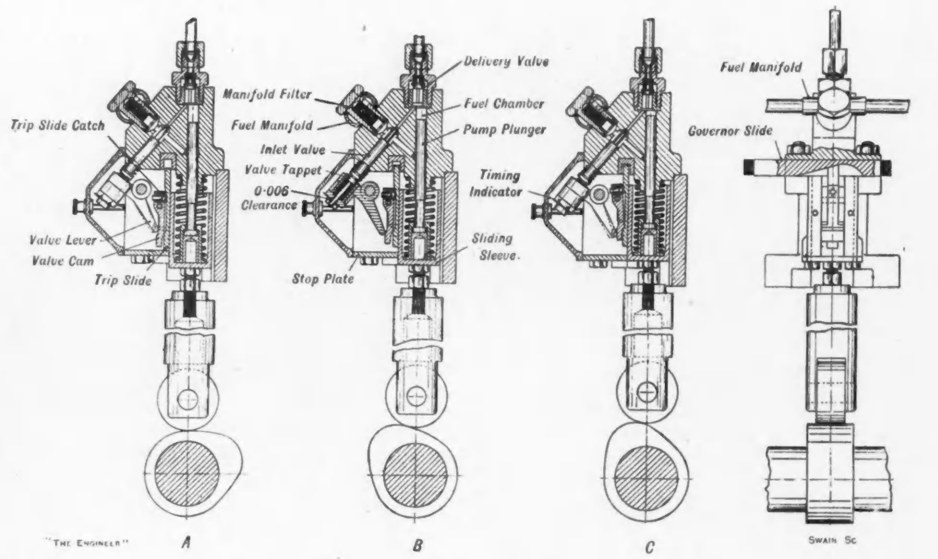


FIG. 48—OPERATION OF FUEL PUMP—BLACKSTONE

The grouping of the controls, fuel pump, tachometer, mechanical lubricators, auxiliary pumps, and air compressor for starting and manœuvring air is clearly indicated in Fig. 46. The governor controls the engine speed over the complete range down to one-quarter speed, and direct reversing is carried out in the usual way by a single hand wheel, the rotation of which brings the ahead or astern set of cams into position as required. The main parts of the engine are all lubricated under pressure and the system is fed by two ram type pumps. The provision of a separate scavenge pump not only gives, it is claimed, good scavenging with a charge of cool air, but the arrangement is also one which permits of a more copious supply of oil to the main bearings and connecting-rod bearings than is possible under conditions of crank case compression. Several of these engines have been put to work at sea and are giving, we learn, very good results in service.

Besides the six-cylinder unit referred to there is a two-cylinder unit with separate reverse gear, while another exhibit is a six-cylinder Crossley compressorless oil engine designed to develop 300 B.H.P. at 500 r.p.m. This engine has been specially built for electric lighting services and is suited for direct coupling to a 200-kW generator.

Blackstone and Co., Ltd.

Besides a 55 B.H.P. horizontal cold-starting "Spring Injection" engine similar to those we have described at previous exhibitions, there are to be seen on the stand taken by Blackstone and Co., Ltd., of Stamford, a range of engines of various horse-powers for land and marine transport, electricity production, and various other power duties. We have chosen for illustration in Fig. 33, page ix, a 40 B.H.P. four-cylinder marine engine which is shown on the stand fitted with a propeller and reversing gear. It has a cylinder bore of 4⅝in. and a stroke of 6in. and is fitted with the makers' new "CCC" injection system. The operation of this system can be followed from the series of drawings in Fig. 48. In A the fuel pump plunger is shown returning after the delivery stroke. It is constrained to follow the cam by a spring and draws in after it a supply of fuel oil from the inlet manifold, in which is situated a suitable filter. The inlet valve is automatically operated by the movement of the plunger through the valve lever, valve cam, and trip slide, which are clearly marked on the drawing. The valve cam, trip slide and plunger all move together, but the trip slide is additionally controlled by the governor, as will shortly be explained. In B the upward stroke of the plunger has begun and it will be observed that, the valve cam having risen, the inlet valve has been closed by the operation of the valve lever. Fuel oil is therefore now forced under pressure through the delivery valve to the sprayer and injected into the cylinder. At a certain point in the stroke, determined by the governor, the motion of the trip slide is stopped. Consequently, as shown in C, the valve cam falls into the recess cut in the side of the trip slide and allows inlet valve to open. Pressure is at once relieved, the delivery valve closes, and the remainder of the oil is returned to the manifold. It will be seen that the inlet valve, under the influence of this mechanism, always closes at the same point of the cycle in the engine cylinder, but the period of injection is variable according to the load on the engine. Besides serving for the inlet of the fuel and the spill for the excess the inlet valve serves another purpose. Should there be any stoppage in the sprayer or pipe line the valve tappet gives way and allows the fuel to escape and return to the manifold. The valve therefore acts as a relief to protect the pump from the effects of excess pressure. It is claimed for this mechanism that it ensures a sharp opening and rapid closing of the sprayer valve and eliminates the risk of "dribble." Less power, it is said, is required to operate the governor mechanism and thus closer governing of the speed is possible. Besides the "Spring Injection" engine and the vertical engines, which are shown as single, twin, three-cylinder, four-cylinder, and six-cylinder types, there is also to be seen the firm's "Fuelol" engine.

Babcock and Wilcox, Ltd.

The full-size boiler exhibits shown on the stand of Babcock and Wilcox, Ltd., of London and Renfrew, have been specially designed to draw attention to the modern trend of development in boiler practice for naval vessels, liners, and cargo steamers, and high-speed cross-Channel ships. It is worthy of note that within recent months several orders have been placed for marine boilers fitted with mechanical stokers. Many of these orders have followed, we are told, the successful installation of similar equipment on the L.M.S. steamer "Duke of Lancaster" on the

Heysham-Belfast run and the Canadian Pacific "Beaver" class cargo ships.

In America valuable experience has been gained with Bailey water walls, not only in power station boilers, but also at sea. In this connection reference may be made to the 638ft. limestone carrier "Carl D. Bradley," which is a turbo-electrically propelled steamer operating on the Great Lakes. In this ship there are installed two Babcock boilers, each having a heating surface of 5630 square feet with 1340 square feet of superheater surface and 52 square feet of Bailey bridge wall area. The boilers are designed to operate at 325 lb. pressure with 278 deg. Fah. superheat and are fired by Westinghouse retort type stokers. This ship has proved, we are informed, to be very economical in service.

In order to show a typical example of modern boiler construction embodying the various developments above referred to the firm is exhibiting—see the right-hand view above, Fig. 50—a full-size section of a standard B. and W. type marine boiler, four tube sections wide, fitted with an Erith-Roe stoker, one retort wide, with motor drive. The stoker is being shown in operation in such a way as to indicate clearly its manner of operation. The boiler, as our illustration shows, is complete with steel casings at the side, front, and rear, and the usual mountings and accessories, including soot blowers, are shown. The other boiler exhibit is the full-size section of the new small tube SX boiler, which we illustrate in Fig. 49. It is two sections wide and is similar in construction to that supplied for H.M.S. "Guardian," which boiler was recently subjected to extended tests at the firm's Renfrew works. The furnace is of the ordinary refractory construction arranged for oil firing and a B. and W. standard pressure type oil sprayer is fitted in the wall under the lower horizontal header. In the opposite wall there is a Babcock-Clyde single-nozzle blower, a section through which is reproduced in Fig. 51.

As Fig. 49 indicates, the SX model is complete with air casings, which deliver the heated air down the back of the boiler to the underside of the fire-grate. The design features of the small-tube SX boiler were fully described in THE ENGINEER of September 25th, 1931, and the arrangement of the pressure parts will be clearly seen from the accompanying engraving. In the shore trials at Renfrew on the SX boiler built for H.M.S. "Guardian," the boiler was steamed under low and high-power conditions, and showed rapid steaming with no priming. The boiler, which has no superheater or air heater, is fired by four 900 lb. Admiralty type burners. The heating surface is 5850 square feet with a total boiler weight of 40 tons. The following figures indicate the general run of the results which have been obtained on ratings commensurate with the latest merchant service practice :—

Working pressure	250 lb. per sq. in. (saturated)
Evaporation	50,000 lb. per hour
Overall net efficiency ..	85 per cent. on gross value of fuel
Outlet gas temperature ..	430 deg. Fah.
Evaporation per ton weight	1250 lb. per hour
Evaporation per sq. ft. of heating surface	8·6 lb. per hour
Evaporation per sq. ft. of floor space occupied by boiler	300 lb.

The boiler was also tested with a double furnace utilising eight 900 lb. burners, under conditions of high heat liberation corresponding to naval practice. The results obtained have been plotted in Fig. 52, giving boiler efficiency per cent. on a base of heat liberated in 1000 B.Th.U. per cubic foot of furnace volume. The accompanying curves for naval vessels are taken from Engineer-Captain S. R. Dight's paper on "Naval Water-tube Boilers," read at the spring meetings of the Institution of Naval Architects—see THE ENGINEER, April 28th, 1933—it being assumed that 19,000 B.Th.U. oil was used in all tests. The Scotch boiler curve has been added from tests made by the U.S. Naval Department at Philadelphia. A feature of the SX curve is the high efficiency which is maintained at widely varying loads and the flat nature of the curve, which, it is pointed out, would be further flattened out had a furnace with Bailey water-cooled walls been adopted. The fact that the adoption of such walls materially reduces the slope of the tangent seems to warrant the view held by the exhibitors that one of the next steps in the development of marine boilers will be the fitting of water-cooled walls. The utilisation of such walls has been steadily increasing since their introduction in 1924, nearly ten years ago, and the advantages gained on land boilers seem likely to be repeated at sea. Visitors to the stand will be able to examine for themselves the construction of such walls as applied to marine boilers and to a hopper type furnace for power station work.

We have often referred to the calorised Diamond soot blowers of the valve-in-the-head type, which are also fitted to the boilers referred to, but the Babcock-Clyde pattern, which is exhibited at Olympia for the

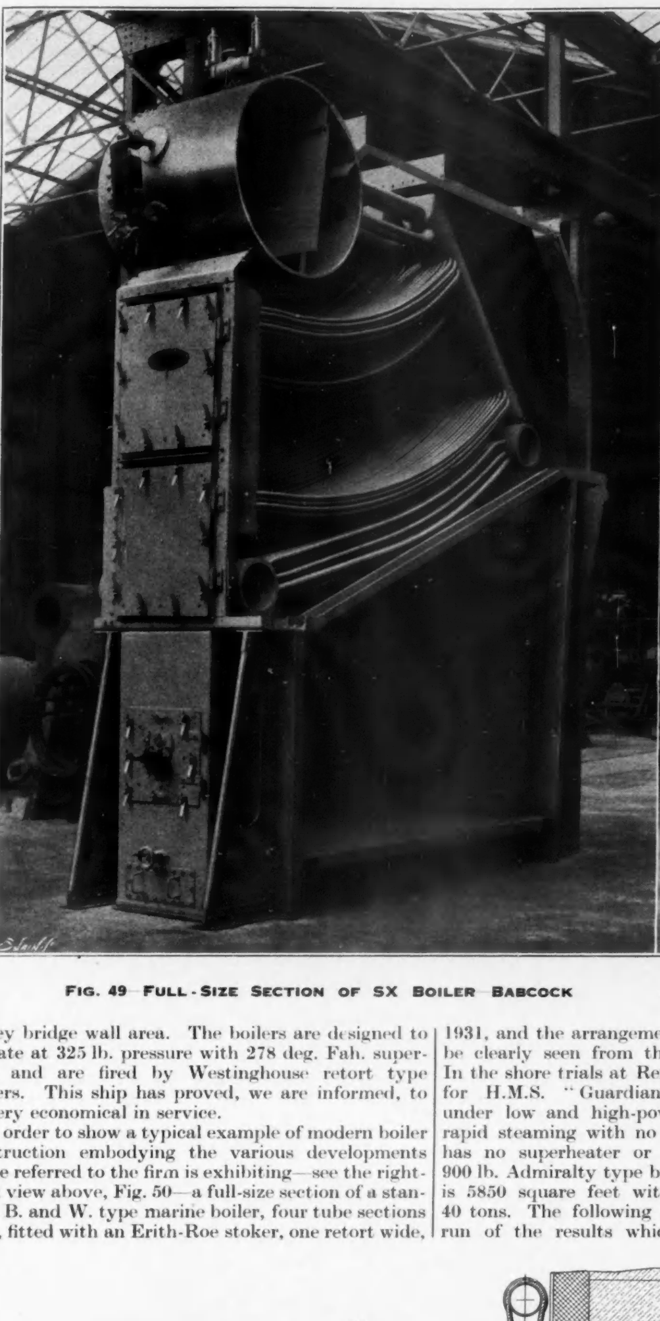


FIG. 49—FULL-SIZE SECTION OF SX BOILER—BABCOCK

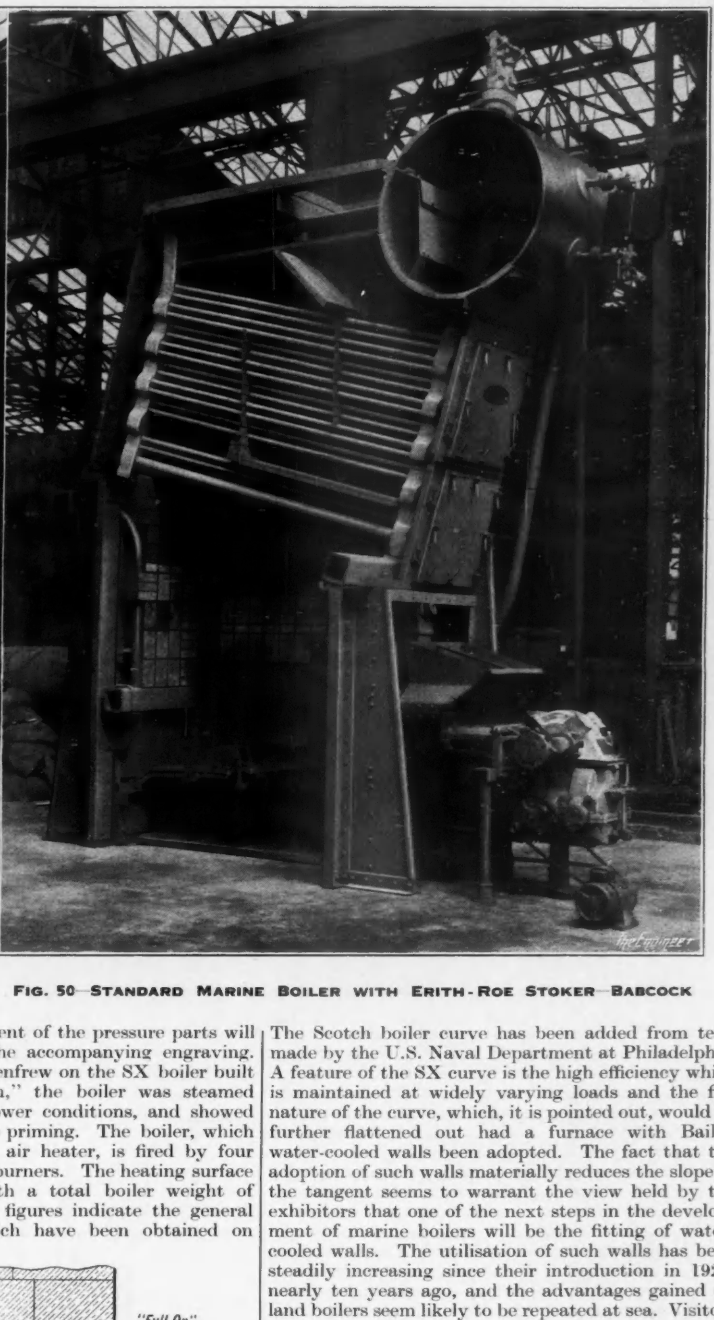


FIG. 50—STANDARD MARINE BOILER WITH ERITH-ROE STOKER—BABCOCK

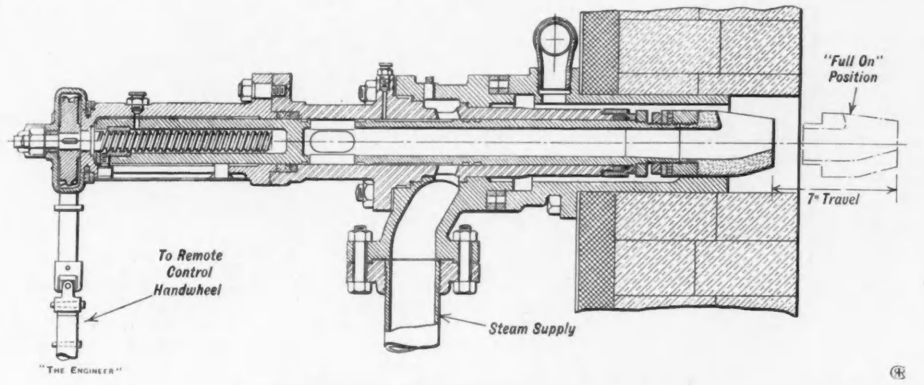


FIG. 51—SINGLE NOZZLE SOOT BLOWER—BABCOCK

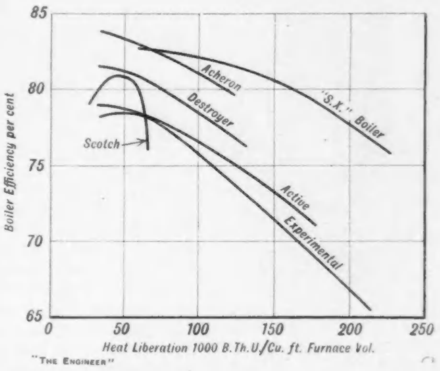


FIG. 52—RESULTS OF TESTS ON SX BOILERS—BABCOCK

first time, breaks new ground, in that by turning a wheel the steam nozzle is advanced into the furnace, steam is admitted while it is in the forward position, and the nozzle is turned through the required arc. By a reversal of the operating wheel the steam is shut off and the nozzle withdrawn. All the movements are automatic and can be read off on the indicator arranged immediately above the operating hand wheel. In the blower illustrated in Fig. 51 the operating wheel is, however, of the remote control pattern and only part of the shaft and the worm drive on the blower spindle is shown in our illustration. The working parts are protected from grit and dust and are lubricated where necessary. Air is used for cooling purposes, the air cooling inlet being on the top of the blower adjacent to the front of the boiler casing. The cover and nozzle of the blower can be withdrawn for inspection and overhaul while the boiler is under steam.

Other items on the stand relate to new developments in fusion welding and boiler specialities manufactured by the firm.

C. A. PARSONS AND CO., LTD.

In conjunction with their associated company, the Parsons Marine Steam Turbine Company, of Wallsend, C. A. Parsons and Co., Ltd., of Heaton Works, Newcastle-on-Tyne, are showing a representative collection of Parsons' products, including power station machinery, pole transformers, fabricated steel work, motor car cylinders and searchlight reflectors. A model of a 30,000-kW turbo-alternator built to a scale of one-sixteenth full size, complete with condensing plant and fuel heating system, represents the machine ordered last year by the Brighton Corporation. Designed in accordance with the firm's latest practice, the actual set runs at 3000 r.p.m. and uses steam at a pressure of 650 lb. per square inch superheated to 850 deg. Fah., which incidentally is some 50 deg. above the melting point of zinc. The steam supply is regulated by two valves working in parallel and controlled by the governor through oil relays. An independent emergency valve is, of course, also fitted to shut down the machine in the event of overspeed or loss of vacuum, whilst to ensure proper heating of the turbine while it is being started motor driven turning gear is fitted. To facilitate the work of this gear and especially to minimise the effort required to start the machine from rest, oil is admitted to the bearings at a pressure of 1000 lb. per square inch, which is sufficient to cause the shaft to float on an oil film and to eliminate static friction. The turning gear also enables the turbine to cool off uniformly and keeps it ready for instant re-starting if necessary.

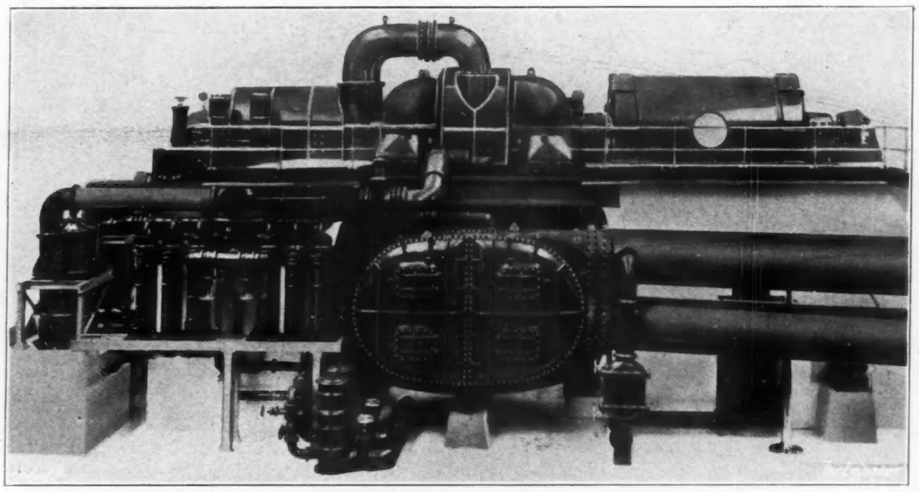


FIG. 53—MODEL OF 30,000-kW TURBO-ALTERNATOR—PARSONS

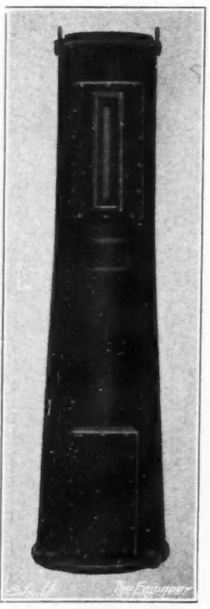


FIG. 54—WATER GAUGE PROJECTOR—PARSONS

The condensing plant is of the inverted Parsons' type with the tube nest in the centre of the shell and the steam is guided down on each side of it by baffles to the bottom of the condenser. The steam is condensed in its passage upwards among the tubes, the condensate being re-heated in falling back through the rising current of steam, so that when drawn off at the bottom of the condenser it is at full exhaust steam temperature. The air is withdrawn at the top of the shell, where it is coolest, and completely free from entrained moisture by a three-stage steam-operated ejector. As there are no baffles of any kind among the tubes, the steam and air flow is not obstructed and the entire surface of every tube can do its proper share of work. The design is claimed to result in an exceptionally high rate of heat transmission, a minimum pressure drop across the condenser, and the highest possible temperature of the condensate. The inverted condenser offers the further advantage that it serves both exhaust branches of the turbine and the need for twin condensers for a double exhaust machine does not exist. After the condensate has been withdrawn from the condenser by a motor-driven centrifugal pump it is progressively heated to a temperature of 340 deg. Fah. by steam extracted from the turbine at four points.

The continuous maximum rating of the totally enclosed alternator is 37,500 kVA at 8000 volts, and it is ventilated on the totally enclosed system, in which the same air is kept in continuous circulation and cooled after passing through the machine by an air cooler included in the circuit. Two motor-driven fans are provided, each of sufficient capacity to enable the machine to develop three-quarters of its rated capacity continuously. A view of the model as shown at the Exhibition is given in Fig. 53.

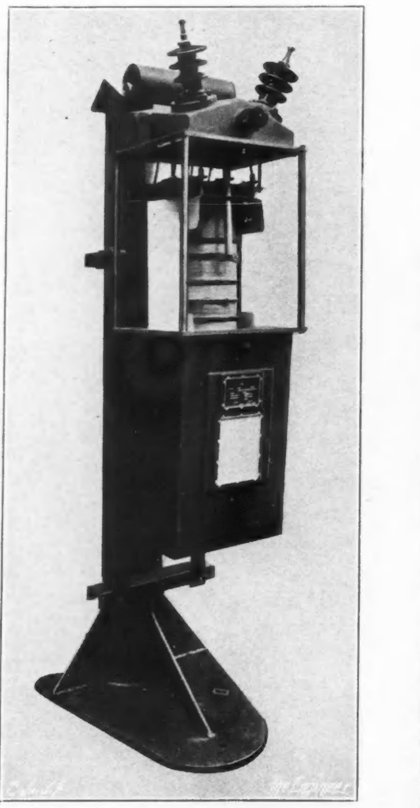


FIG. 55—25-kVA POLE MOUNTING TRANSFORMER—PARSONS

An air cooler for use in conjunction with a turbo-alternator in the manner described and capable of dealing with 36,000 cubic feet of air per minute constitutes another exhibit. To facilitate assembly and withdrawal through the sides of the foundation block it is mounted on rollers. It consists of a nest of tubes terminating in tube plates to which cast iron water boxes are attached, the tubes being held in the unit so as to permit of free expansion and contraction, and any tube may be withdrawn or replaced without disturbing the remainder. Although the tubes in the cooler shown are composed of brass, copper tubes are sometimes used, and each is wound from end to end with a corrugated fin in the form of a continuous spiral, the fins being soldered to the tubes to ensure good thermal conductivity.

The Parsons water gauge projector shown in Fig. 54 has been designed for use in boiler-houses. With its aid an attendant on the firing floor is provided with a brilliantly illuminated image of the gauge glass on the boiler drum, which may be 50ft. or 60ft. above his head. The result is obtained without interference with the actual gauge glass, the image being thrown by optical means on to a ground glass screen mounted on the pedestal on the firing floor and is visible from a considerable distance and through a wide angle. The instrument is shown working in conjunction with a Dewrance water level indicator suitable for pressures up to 700 lb. per square inch, erected together with the necessary projecting apparatus on the gallery over C. A. Parsons' stand, on which the image of the gauge glass can be seen on the screen in the pedestal.

A 25-kVA single-phase pole mounting transformer as shown in Fig. 55 is also to be seen. It has been designed for rural electrification schemes, the ratio being in this particular case 11,000/400 volts. Transformers of this kind are made, however, for primary pressures up to 33,000 volts and for outputs ranging from 10 to 50 kVA. Other electrical exhibits are specimens of the Parsons' patented concentric stator conductors as used in the Parsons' 36,000-volt alternators, and an exciter for a turbo-alternator. Details of the end winding connections for these high-voltage machines are shown in Fig. 56. The exciter is a 35-kW overhung four-pole 150-volt 3000-r.p.m. machine with the armature mounted directly on the main rotor shaft.

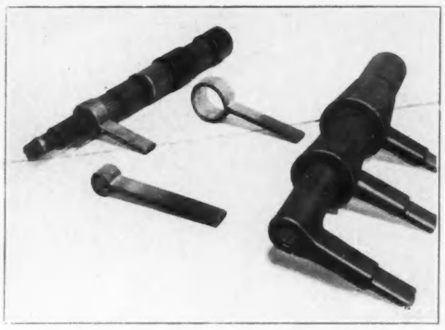


FIG. 56—END WINDING CONNECTIONS—PARSONS

Other exhibits consist of the Parsons borescope, as used at the Heaton works for the detailed examination of the interior of rotor forgings, pipes, &c.; a fabricated steel pipe and expansion piece; motor omnibus cylinders; a gun-metal tail shaft liner for a ship's shaft; silvered glass reflectors for searchlights; and other apparatus and samples of turbine blading. The ductility of the firm's stainless iron blading is illustrated by a piece of blade strip which has been twisted through five complete revolutions without showing any sign of fracture. Another interesting sample is a blade for the exhaust end of a turbine and fitted with the Parsons' patented shield to prevent corrosion. This form of protection is now employed on all Parsons' machines for blades subjected to the erosive action of wet steam and is said to give an indefinitely long life to the blades under the most adverse conditions. The shields consist of intensely hard metal and are fixed by brazing to the leading edge of the blades, and if it should ever be necessary to renew them the job can be done without removing the blades from the rotor.

EDWARD BENNIS AND CO., LTD.

The two main developments in stoker design made by Edward Bennis and Co., Ltd., of 28, Victoria-street, London, S.W.1, since the last exhibition at Olympia have been a modification of the method of supplying air for combustion to the furnaces of a boiler, and the introduction of cold air internally through the grate bars in order to prevent overheating of the metal when using preheated air for combustion. The furnace grates of the new design, which is exemplified on the stand as applied to a three-flue marine Scotch boiler, are composed of a number of hollow trough bars. While the self-cleaning action of the older type is retained, the furnace troughs of the new unit are adapted to suit the supply of air for combustion at a lower pressure and velocity than would be the case with a furnace served by steam jets. It is claimed that the new system overcomes the tendency of the bars to swell under the conditions of high temperature caused by burning fuel in preheated air. Cold air currents forced under pressure through each of the bars from front to rear keep the bars at a comparatively low temperature, while air for combustion is introduced under pressure into the front tubular end of each trough by separate nozzles. These air nozzles are arranged upon a common duct fixed immediately in front of the grate in such a way that their centres correspond with those of the fire-bar troughs. The air pressure is maintained by a fan.

THE BRITISH OXYGEN COMPANY, LTD.

Manufacturers of articles such as tanks which are made up from steel plate have hitherto found it necessary to make two cuts for preparing the bevels on the meeting edges of the plate. The edges, of course, are usually bevelled before the plate is bent into shape. If plates are purchased from the steel makers to a definite size sufficient for making up the article with no waste, the ends must each be bevelled as a separate operation. If, however, the steel plate is purchased in sufficient size to permit of two or more plates being cut from it, the separation may be made by two cuts, each of which prepares the bevelled edge ready for welding. This arrangement is made possible by the new device introduced by the British Oxygen Company, Ltd., of Edmonton, London, which consists of a two-nozzle head suitable for attachment to any of the firm's ordinary machine cutting blow-pipes. Three different angles of cut are available by means of different heads, and heads will, we understand, shortly be available for cutting angled bevels of 60 deg., 75 deg., and 90 deg. on any thickness of plate from ¼in. to 1in. The device is illustrated in Fig. 57.

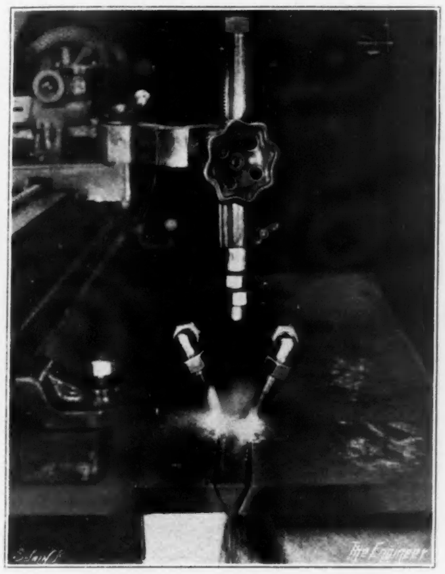


FIG. 57—DOUBLE BEVEL CUTTING ATTACHMENT—BRITISH OXYGEN

The edges left by the cut are, it is claimed, perfectly smooth and no further preparation for welding is necessary beyond a brushing to remove the loose scale which usually adheres to portions of the cut. Needless to say, this device is only for attachment to cutters working on straight-line cutting machines and is not suitable for use on profile cutting machines. Some doubt sometimes exists concerning the desirability of preparing welding bevels by gas cutting, and for several years it has been the practice in many industries to prepare welding bevels by hand operated flame cutter. If hand cutting is already employed, it is reasonable to assume that machine cutting can also be employed with a greater degree of certainty and uniformity of results. With these facts in mind, the firm recently undertook a series of comparative tests on bevels prepared in the following manners:—Saw cut; hand oxy-acetylene cut; machine oxy-acetylene cut; machine oxy-coal gas cut. The average results obtained are given below:—

	Yield point. Tons per sq. in.	Breaking load. Tons per sq. in.
Saw cut	18·25	25·35
Hand oxy-acetylene ..	18·0	25·85
Machine oxy-acetylene ..	18·6	23·95
Machine oxy-coal gas ..	18·4	23·8

It will be noticed that the results do not indicate any appreciable difference between the various methods of preparation. The welds were made using the oxy-acetylene hand process, the same welding rods being employed throughout; after welding, the weld surface was machined down flush with the surface of the plate. The welds themselves were very consistent and for each condition of bevel preparation four welds were made. The use of these special cutting heads provides many possibilities of application; apart from use on steel plates they have already been applied to the cutting of tubes used for heating and supply installations. The cutter with the heads is mounted in a special machine which traverses the cutter circumferentially round the tube.

Besides this double cutter head the firm is showing its usual large range of cutting machines of various types, together with specimens of parts cut. Demonstrations are continually being made, both on the machines and with the hand welding and cutting machines made by the firm. Among the most recent productions to be seen on the stand are new blow-pipes for glass working; blow-pipes for removing defects from semi-finished steel and also for machining slabs and bars of steel to reduce sizes; jet welding blow-pipes for increasing the speed of hand oxy-acetylene welding; and a new welding rod for depositing metal on worn or battered rails. In connection with the last-mentioned it is claimed that while the characteristic brittleness of electric welds is avoided the metal deposited is elastic and accommodates itself to the underlying rail metal to which it adheres. Provided the correct procedure is observed during the making of the deposit, the deposited metal will not flake or split away from the rail metal. The rate of deposit and its shape can be easily controlled by the operator. Furthermore, the deposit may even be hammered to obtain a smooth running surface, so eliminating the necessity for grinding. The makers give a figure of about 300 Brinell as the hardness of the deposit and claim that the rail metal adjacent to the weld is not softened.

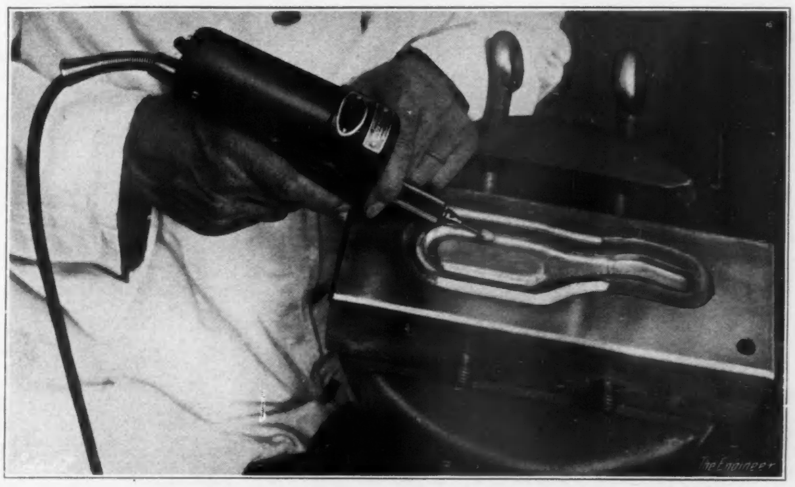


FIG. 58—ELECTRIC GRINDER FOR MOULDS AND DIES—BOSCH

BOSCH, LTD.

The principal exhibit of Bosch, Ltd., of Larden-road, Acton, W.3, consists of mechanical force feed oil and grease lubricators for the lubrication of steam and oil engines, air compressors, machine tools, colliery and brick-making plant, rolling mills, &c., and a variety of electric tools. The 50,000 r.p.m. grinder shown in Fig. 58 is suitable for re-machining press and stamp tools which have been distorted during the hardening process, for cutting from the solid irregular shaped articles, for smoothing off burrs and for polishing. The tool is driven by a universal series-wound motor, suitable for A.C. or D.C., and may be supplied for pressures of 110, 125, 150, 220, or 240 volts. At normal load the consumption is 50 watts. A built-in fan serves for cooling the machine, which transmits its power to the grinding spindle from a pulley serving as a fly-wheel, and giving a speed ratio of 1 : 4, the speed of the rotor being 12,500 r.p.m. The high spindle speed which produces the required circumferential velocity, even with very small grinding wheels, the smooth running and the good pull, combine to make the grinder suitable for performing the most accurate and delicate work. The grinder may be used for machining materials such as hardened and non-hardened steel, grey iron, bronze, brass, silver, glass crystals, and semi-precious stones. For machining glass crystal, ceramic products, &c., the machine is equipped for wet grinding, whilst for polishing, suitable polishing attachments are supplied.

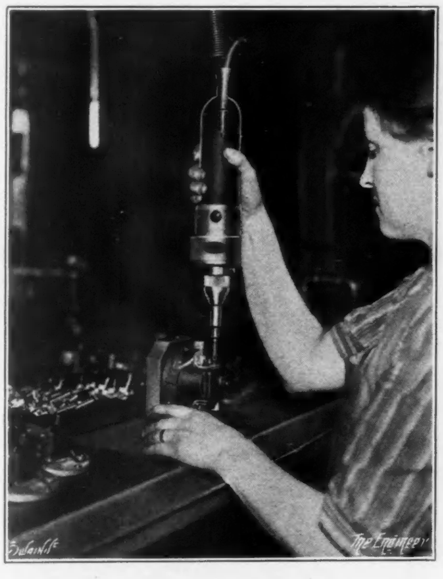


FIG. 59—ELECTRIC SCREWDRIVER—BOSCH

The electric screwdriver, shown in Fig. 59, is suitable for use in all industries in which screws of a similar nature have to be screwed tightly into metal or wood. It is light and easy to manipulate, and a slipping clutch ensures that the drive blade comes to rest immediately the screw has been driven home and when the driver has been removed from the slot. Special centring sleeves for picking up and holding any type of screw are supplied. The motor is a universal machine suitable for A.C. or D.C.

The hand motor shown in Fig. 60 may be used for numerous purposes, such as finishing off dies and moulds, machining patterns, fettling castings and welds, removing burrs, cutting oil grooves, drilling holes in steel, &c., up to ¼in. diameter and in stone, glass, ceramics and wood up to $\frac{5}{16}$in. diameter, reaming small holes, roughing rubber, and decarbonising engines by means of rotary wire brushes. The motor is a universal machine suitable for A.C. or D.C., and is supplied for pressures of 110, 150, and 220 volts, the consumption under load being 50–60 watts. The armature speed is about 20,000 r.p.m., which is reduced to 1500–1600 r.p.m. by means of reduction gearing.

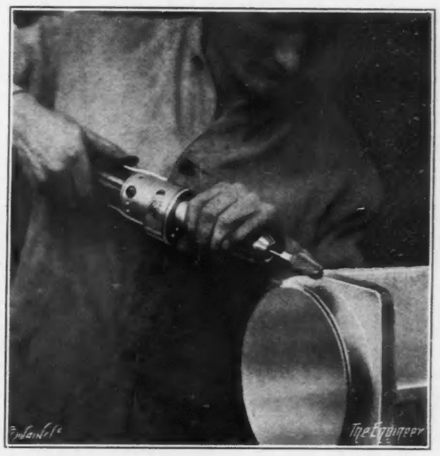


FIG. 60—ELECTRIC HAND MOTOR—BOSCH

JOHN I. THORNYCROFT AND CO., LTD.

On the stand of John I. Thornycroft and Co., Ltd., of London, Southampton, Basingstoke, and Reading, prominence is given to the firm's new compression-ignition engines of the high-speed, heavy-oil type, which are rapidly finding increasing uses for marine and land transport work. Some of the engines shown have been exhibited at previous Exhibitions, but a new addition to the series is the R M 4 engine, now on view for the first time.

In Fig. 61 we reproduce sections through the engine, and on page viii, Fig. 28, we illustrate a similar unit of the six-cylinder type which has a designed output of 50 to 65 B.H.P. at 1200 to 1600 r.p.m.

The new four-cylinder compression-ignition engine has a bore of 4in. and a stroke of 6in., with a rated output of 36 B.H.P. at 1200 r.p.m., with a brake mean effective pressure of 78 lb. per square inch.

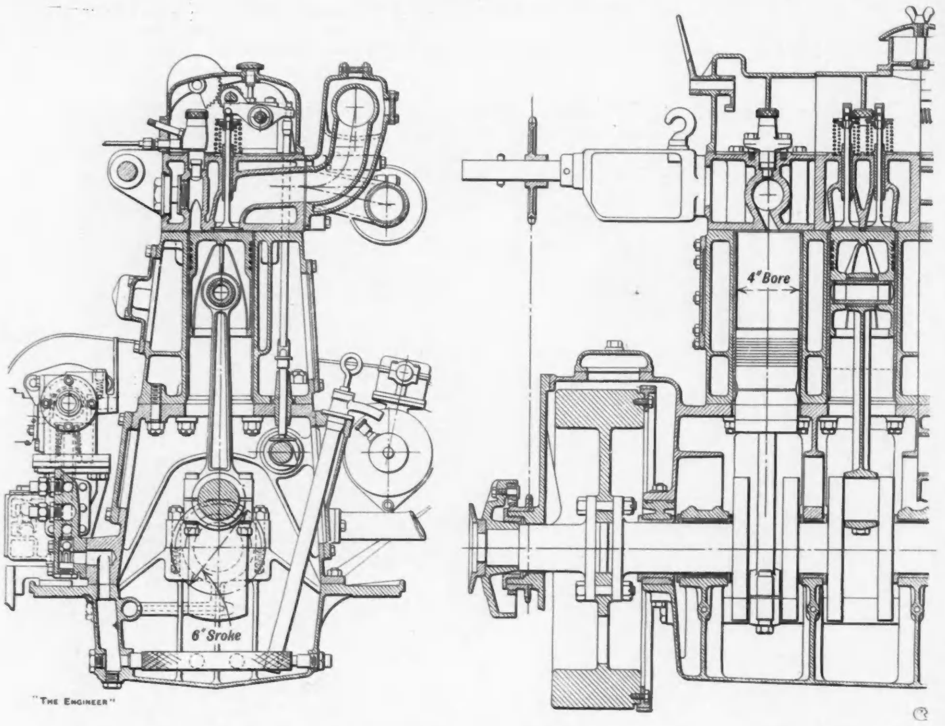


Fig. 61—Sections through 36 B.H.P. Four-Cylinder Oil Engine—Thornycroft

It can be started by hand by means of the usual overhead shaft and chain drive, or, if required, an electric starter can be supplied.

The fuel consumption per hour is approximately 2 gallons, or 9 litres, and the lubricating oil consumption per hour is approximately 0·6 pint, or 0·34 litre. The engine, generally, has been designed to meet the requirements of the British Admiralty for an engine of this type, and complies with the requirements of Lloyds and the Board of Trade as to size and materials of component parts. It can be built under survey if required.

As the drawing Fig. 61 shows, the crank shaft is carried in the bottom half of the crank case in main bearings of large diameter, supported by ribs. The top half of the crank case, which serves to transmit the stresses from the crank case to the cylinder block, is a stiff casting, strongly ribbed and provided with large doors, through which pistons, connecting-rods, and all main bearings may be removed without dismantling. The clutch and reversing gear are integral with the engine, in so far that they are contained in a separate casing bolted rigidly to facings on the main crank case. In the event of a reversing gear not being required, this casing may be replaced by an end cover, which renders the engine suitable for dynamo driving or other stationary purposes.

The main cylinder block is cast in chromium iron and is furnished with large doors, through which the jackets may be easily cleaned. It is fitted with cylinder liners of Nitralloy cast iron, honed in place after fitting.

The pistons are of an aluminium light alloy, and carry four main rings and one oil-control ring, while the gudgeon pins are a floating fit in the piston and are prevented from coming into contact with the cylinder walls by brass pad pieces at either end. Special interest attaches to the use of a flat-topped piston and an auxiliary chamber with an oblique passage connecting it to the combustion space. The arrangements are clearly shown in drawing Fig. 61.

The cam shaft is mounted in the top half casing and actuates the valves by means of rockers and push-rods. Provision is made for the lubrication of all the valve gear by pressure from the main oil pump, which is of the plunger type and runs at half-engine speed. All the auxiliaries, such as fuel pump, oil pump, bilge pump, and tachometer drive, are mounted on the engine in such a way as to be immediately accessible for examination and repair without any dismantling work having to be done. Both the governor and the control gear are incorporated in the fuel pump, which is at present of Bosch manufacture, though any other make of pump, interchangeable as regards dimensions, can be fitted.

The weight of the engine with the crank case of cast iron, as illustrated in Fig. 61, is approximately 19½ cwt., or 990 kilos., but where lightness is specially required the crank case can be manufactured in aluminium alloy, the corresponding weight being approximately 16 cwt., or 787 kilos. The above weights do not include, however, the electric starter, which, including the battery, makes an addition of approximately 1½ cwt., or 76 kilos.

In addition to the compression-ignition engines above referred to, a representative range of Thornycroft paraffin marine engines, from 9 up to 55 B.H.P., fitted with reversing or reversing and reduction gears, is displayed. There are also shown examples of Thornycroft oil-fuel-burning equipment, and ships' propellers, whilst models of naval vessels, merchant ships, and yachts built by the firm illustrate the varied products dealt with at the firm's different establishments.

Foundry Equipment, Ltd.

On the stand taken by Foundry Equipment, Ltd., of Westminster, are to be seen chain blocks and combined chain blocks and trolleys, suitable for a wide range of loads. The "Felco" triple gear chain blocks have been recently introduced by the firm, and are here exhibited for the first time. These blocks are made in a range of sizes from ½ to 10 tons, and the drawing reproduced in Fig. 62 shows the 1-ton size.

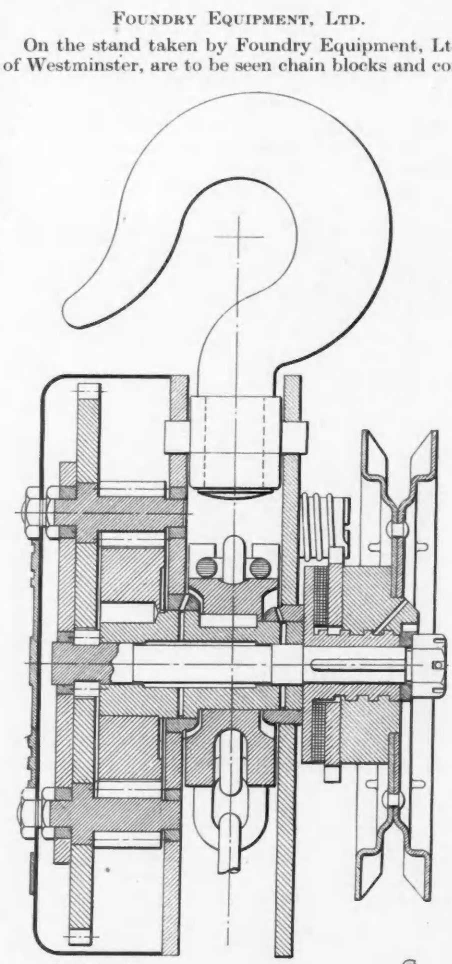


Fig. 62—1 Ton Chain Block—Foundry Equipment

The main frame is made of solid steel plates, and is so constructed that the makers claim it to be unbreakable and not liable to distortion. The hand wheel, which is a heavy gauge steel stamping instead of the casting sometimes employed by makers of these devices, is keyed on to the end of the pinion shaft. This shaft extends right across the mechanism, and carries at its further end a pinion engaging with two intermediary hardened, machine-cut gears. Pinions cut solid with the larger wheels engage with the central load wheel gear, which is keyed to a shaft encircling the pinion shaft. In the centre and keyed to the load wheel shaft is the load wheel itself. Braking is effected by a screw plate, ratchet, and pawl, all of hardened steel and special fibre friction washers. This device is mounted just beside the hand wheel. Lubrication of the gears by an ample supply of thick grease contained in the steel casing enclosing them has been adopted, while the various bearings have radial oil grooves cut in steel plates. The makers inform us that all these blocks supplied are tested to 50 per cent. overload working and 100 per cent. overload static. A photograph reproduced in Fig. 63 gives some idea of the appearance of a block of larger size—8 ton.

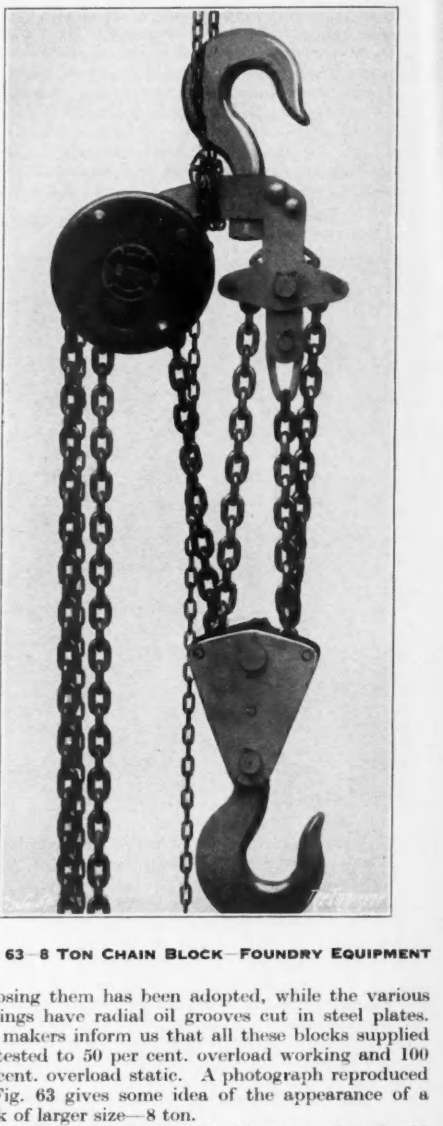


Fig. 63—8 Ton Chain Block—Foundry Equipment

In addition to these chain blocks, notice should be taken of the combined chain blocks and trolleys. By building the block into the trolley, the makers have reduced considerably the headroom from the underside of the joist to the inside of the bottom hook when in the highest position. In the half-ton size, for instance, this dimension is only 11½in. and in the 2-ton size 17½in.

Thomas and Bishop, Ltd.

The firm of Thomas and Bishop, Ltd., besides showing the "Flexo" belt dressing which it has been manufacturing for over thirty years and the "Flexo" tinning compound, for which it is claimed that two pieces soldered together by its means cannot be torn apart without risk of fracturing the metal, is also showing an entirely new range of products known as "Kester" solders. This series of self-fluxing wire solders is made of virgin tin and lead. Each wire contains within it, like the lead within a pencil, the flux suitable to the purpose for which the solder is to be used and in a proportion which has been found experimentally to give the best results. The three chief types of Kester solder are "acid core," which is of the general utility variety and is to be preferred for outdoor work; "rosin core," suitable for wireless and telephone work, which leaves only a transparent residue and prevents corrosion and electrical leakage while being harmless to metal parts; and "body solder," which is specially designed for the repair of damaged motor car mudguards and bodies.

A Seven-Day Journal

The Proposed Gibraltar Tunnel.

PRELIMINARY surveys for the proposed tunnel under the Strait of Gibraltar, show that the geological conditions are favourable to the successful carrying out of the scheme. When the surveys are completed, towards the end of next year, it is hoped to constitute an international company with British, French, and Spanish capital, but the work of constructing the tunnel will not be started until there is some assurance that the African railway projects will be put in hand at the same time. One of these is a railway along the west coast through French Morocco and the Rio del Oro to Dakar for the traffic with South America; another is the Transafrican railway across the Sahara Desert, which will be connected up with the Belgian Congo railway system, and eventually with the railway to the Cape; and, finally, there is a scheme for extending the railways across North Africa to Egypt. The lesson of the tunnel through the eastern Pyrenees, which has failed to fulfil the promise of promoting commercial activity made at its inauguration some years ago, is not lost upon the promoters of the Gibraltar tunnel, who intend to make sure that railway enterprise in Africa will justify its construction. The Spanish decree of December, 1931, which modified the character of the Commission of Inquiry formed in 1928, declared that the object of the tunnel was to make the Spanish railway system a link in a chain of communications with Europe, Africa and America. It is proposed to construct the tunnel from a point 5 miles west of Tarifa in Spain to Cale Hermosa in Spanish Morocco, a distance of about 20 miles. There will be two tunnels, with lateral tunnels every 200 m., and the maximum depth below water level will be 370 m. The maximum gradients will be 3·6 per cent. The strategical value of the tunnel will raise political problems which will have to be settled before the undertaking can be put in hand.

The Ryburn Reservoir.

ON Thursday afternoon, September 7th, the new Ryburn reservoir, near Sowerby Bridge, was formally opened by Councillor Charles Hopkinson, the Chairman of the Wakefield Corporation Waterworks Committee. The curved concrete dam which has been constructed across the valley has a height of 100ft. and a width of 600ft., the curve being on a radius of the same dimension. The capacity of the lake thus formed is 220 million gallons. The downstream face of the dam is stepped, and narrows downwards to 87ft. at the base. Over it 1,300,000 gallons per day of compensation water are allowed to flow. The whole of the work has been carried out to the designs and under the supervision of Mr. C. C. Smith, the Corporation waterworks engineer. Nearly all the concrete required was poured under gravity, and a feature of the construction was the use of bore-holes filled with cement under pressure, which extend over the parts below and adjacent to the sides of the dam. The total cost of the Ryburn dam is about £245,000, making a total of between £500,000 and £600,000 spent on the scheme so far completed, which includes a 23-mile pipe line to Wakefield with the tunnels and bridges required. A further reservoir, which is to be placed higher up the valley, will complete the scheme for the construction of two reservoirs at a cost of about £960,000, which was sanctioned under parliamentary powers in 1924.

Olympia.

ON Thursday, September 7th, the Shipping, Machinery and Engineering Exhibition was opened by the Earl of Athlone. He spoke optimistically of the general outlook in trade and industry, and gave examples to illustrate the improvement that was taking place. In shipbuilding, for instance, last month had been the best in the year on the Clyde, orders for five ships having been placed and five ships having been launched. Although the total output for the month was only a little over 9000 tons, there was a prospect that the total for the year would show an improvement on that for last year. Similar figures were true for other shipbuilding centres. That revival, coupled with the possibility of new naval orders, justified the expectation that better times were coming for engineering in all its branches. At the luncheon which followed, Lord Stonehaven, presiding, expressed the opinion that the Exhibition was a testimony to the technical skill, ingenuity, courage, and perseverance of those engaged in the shipping, engineering and machinery industries. In the evening a dinner was held in honour of and to welcome overseas visitors. It was a cheerful function, and the remarks of the various visitors who spoke gave proof of the bonds that hold the widely separated countries of the Empire together. After the toast of "International Shipping and Engineering" had been proposed by Mr. W. A. Tookey and acknowledged by Mr. J. Foster Petree, Mr. D. A. Bremner, in a speech with just that touch of humour so necessary after dinner, proposed the toast of "Our Overseas Guests." Mr. B. H. J. Tubb, of Rhodesia, and Councillor E. H. Van Whitt, of South Africa, responded. Sir Thomas Wilford, High Commissioner for New Zealand, proposed the toast of "The Chairman," and the response by Lord Stonehaven brought the day's proceedings to a close.

The Proposed Water Grid.

DURING the past week opinions divergent in character, some of them with inspired knowledge, no doubt, have been expressed on the proposed water grid, a recent subject of much non-technical writing. Speaking at the opening of the Ryburn reservoir of the Wakefield Corporation waterworks last week, Mr. Arthur Greenwood, Minister of Health in the last Labour Government, said that the problem of water supply had got beyond the scope of the single authority. We were now, he said, being led in the direction of looking at water supply from a much wider view, and he expressed the hope that in six years something like a national plan for conserving and distributing water would be adopted. In a conference of Lancashire Urban District Councils, which took place at Fleetwood on Saturday, September 9th, Professor Abercrombie, of Liverpool, expressed a similar hope, and pointed out the need of regional planning, and the saving in expense thereby attainable. Mr. G. M. Robertson, of Fleetwood, the Chairman of the British Waterworks Association, referred at the same conference to the supply problem, but pointed out that the conditions of electricity and water supply were entirely different. In water there was the question of gravitation, the source of supply, and the method of distribution. Recently the Government had been seeking information from the water authorities as to the supplies of water available, what reserves they had, and the extent of the gathering grounds, but he was personally of the opinion that it would be a long time before there was a water "grid" in this country.

Electricity Supply.

THE official returns rendered to the Electricity Commissioners show that 928 million units of electricity were generated by authorised undertakers in Great Britain during last month, as compared with the revised figure of 816 million units in the corresponding month of 1932, representing an increase of 112 million units or 13·7 per cent. The number of working days in the month, excluding Sundays and Bank Holiday, was the same as last year, namely, twenty-six. During the first eight months of 1933, up to the end of August, the total amount of electricity generated by authorised undertakers was 8329 million units, as compared with the revised figure of 7718 million units for the corresponding period of 1932, representing an increase of 611 million units or 7·9 per cent. Following the conclusion of an agreement last July for two power stations of J. and P. Coats, cotton and thread manufacturers, to be brought into the Central Electricity Board scheme, the Board had entered upon negotiations with other industrial concerns, owning their own generating stations. The number of stations in industry, coal mines, commerce, &c., is in excess of 4000, and although it is not anticipated that all people generating their own current will take advantage of the "Grid," it is expected that many of them will do so.

A B.A. Luncheon Party.

MR. R. W. ALLEN, the President of Section G of the British Association, gave, on September 12th, a private luncheon at the Grand Hotel, Leicester, at which were present the President of the Association (Sir Frederick Gowland Hopkins, Pres. R.S.), Sir Josiah Stamp (Treasurer, British Association); the two General Secretaries (Professor F. J. M. Stratton and Professor P. G. H. Boswell), Sir Henry Fowler, K.B.E., the members of the Committee of Section G, together with the Recorder, the Secretaries, and the Local Hon. Secretary, and a number of other guests. The proceedings were entirely informal, but Sir Henry Fowler could not resist the opportunity of making a short speech, in which he spoke in a quite intimate manner to and about the President, recalling with pride the work done by Mr. Allen's father in the cause of engineering progress and education. Mr. Allen replied in a similar strain, ruling Sir Henry absolutely out of order. Expressing his personal pride at having been selected as President of Section G this year, Mr. Allen commented on the enormous ramifications of the work of the various Sections of the British Association and of the difficulty of covering all the ground which was made available, especially in the way of visits. For that reason he feared that some of the works which were open for inspection did not receive such large parties as might have been anticipated. In the same way he commented on the difficulty of giving adequate time to the discussion of the papers presented to Section G. (There are those who incline to the view that Section G may itself have to be sectionalised before long in order to be able to deal with all the papers that are available.) Mr. Allen concluded by mentioning that although there were responsibilities for the President of Section G, they were considerably lightened by the work of the Recorder, Mr. J. S. Wilson, and the two Secretaries (Dr. S. J. Davies and Mr. J. E. Montgomrey)—a tribute in which we ourselves would like to join in respect of the manner in which the Press is catered for in Section G.

A Coke Problem.

IN the course of the William Young Memorial Lecture, which was delivered in Paisley on Thursday, September 7th, by Dr. F. S. Sinnatt, Director of Fuel Research, London, before the annual meeting of the North British Association of Gas Managers, the lecturer put forward a strong plea for the continuance of a united attack by the British gas industry on the coke problem. Dr. Sinnatt said that the problem of domestic heating would only be solved when an "all-purposes" coke, which would be suitable for every domestic requirement, was manufactured. Large-scale experiments were being carried out by a number of gas companies and coke manufacturers, both upon the blending and the production of special cokes. Smokeless fuel made by the carbonisation of coal at lower temperatures was, of course, suitable for ordinary household purposes. The title of Dr. Sinnatt's lecture was appropriately "Young, Beilby, and Some Experiments on the Carbonisation of Coal." In it he paid a warm tribute to the pioneer work of William Young; to Sir George Beilby, the first Director of Fuel Research, and to the late Professor Thomas Gray, of the Royal Technical College, Glasgow, who was Superintendent of the Fuel Research Station.

The Scottish Oil Industry.

SOME interesting figures with regard to the oil supplies of Great Britain are contained in the report of the Petroleum Department, which is included in the twenty-fifth annual report of the Chief Inspector of Mines, for 1932, just issued by the Stationery Office. The report states that although this country ranks as the third largest user of petroleum products, next to the United States and Russia, both large oil-producing countries, there are, apart from the oil shale field in Scotland, practically no proved natural oil supplies in Great Britain. According to the report, the Scottish shale oil industry has been seriously contracting. Oil shale is mined in Mid and West Lothian, and the output in 1932 was 1,369,000 tons, valued at £363,000, as compared with 1,733,000 tons, valued at £482,000, in 1931. The amount of crude oil treated at the refinery was 29,679,000 gallons in 1932, compared with 36,524,000 gallons in 1931. The decrease in output, it is explained, was due to the fact that in the autumn of 1931 it had been found necessary, owing to the low level of prices which petroleum products had reached, to effect a contraction in the size of the industry by the elimination of the less efficient crude oil works, shale mines, and one refinery. By the use of the most up-to-date methods, and the cracking of the heavy oil to produce larger quantities of motor spirit, the industry has, however, been maintained in existence. Reference is also made to the scheme for rationing work recently introduced. The scheme has met with an excellent reception throughout the shale oil district, and information in the possession of the Department shows that a loyal effort has been made by all concerned to ensure its success.

High Wycombe Waterworks.

ON Saturday last, September 9th, Lord Cottesloe, the Lord Lieutenant of the County of Buckingham, opened the new waterworks extensions at High Wycombe, which have been designed to supply a wide area in the southern part of the county. The new scheme, now completed, includes a bore-hole and pump-house at Pann Mill, with reservoirs at Bowerdean and Widdenton Park Wood, and interconnecting steel mains. The bore-hole has a diameter of 42in. and a depth of 268ft. It is lined to a depth of 90ft., and at the top there is a well 7ft. diameter, extending to a depth of 34ft. A yield of 150,000 gallons per hour has been obtained at a depth of 48ft. from the surface. The pumping plant comprises a two-stage bore-hole pump at a depth of 80ft., which lifts the water to the suction of the two surface pumps. One of these is a six-stage centrifugal pump designed to deliver 50,000 gallons per hour to the Widdenton Park Wood reservoir, and the other a three-stage centrifugal pump with a capacity of 100,000 gallons per hour, which serves the new low-level reservoir at Bowerdean. The interconnecting mains are 15in. diameter and are of solid drawn steel. The pumping plant was supplied by the Worthington-Simpson Company, Ltd., of London and Newark, and is electrically driven, current being taken from the local supply undertaking at 6000 volts and transformed down to 400 volts at the motors. The two reservoirs are constructed in reinforced concrete on the Hennebique system, and are each divided into two compartments. The Bowerdean reservoir has a 2,000,000-gallon storage capacity, while that at Widdenton Park Wood has half that capacity. The consulting engineer for the scheme is Mr. W. Vaux Graham, M. Inst. C.E., M.I. Mech. E., of Westminster, who collaborated with the waterworks engineer and manager, Mr. S. Young. The cost of the new works referred to above is approximately £78,000.

The Shipping, Engineering and Machinery Exhibition at Olympia.

No. II.

(Continued from page 230, September 8th.)

THOMAS MERCER.

SINCE the last Shipping, Engineering and Machinery Exhibition at Olympia, Thomas Mercer, of Eywood-road, St. Albans, engaged for many years in the manufacture of accurate time measuring instruments, has introduced a wide range of measuring gauges, many of which are exhibited at the present show. For the measurement of barrels or cylinders, gauges from ⅞in. to 36in. capacity are displayed. The former are used for measurements on tubes, &c., whilst the latter are suitable for use on oil engine cylinders and other objects with relatively large bores. There are also dial micrometers for use in printing, rubber, sheet metal, and general works. Depth gauges of the diaphragm type, for use in ship and other tanks, up to 9ft. deep, and time measuring instruments for use on ships constitute other exhibits.

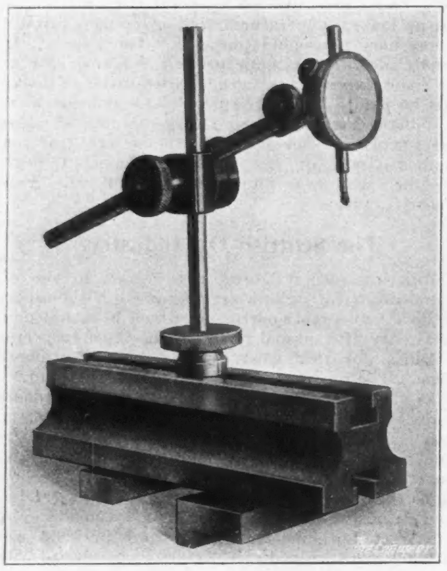


FIG. 28—DIAL TEST INDICATOR—MERCER

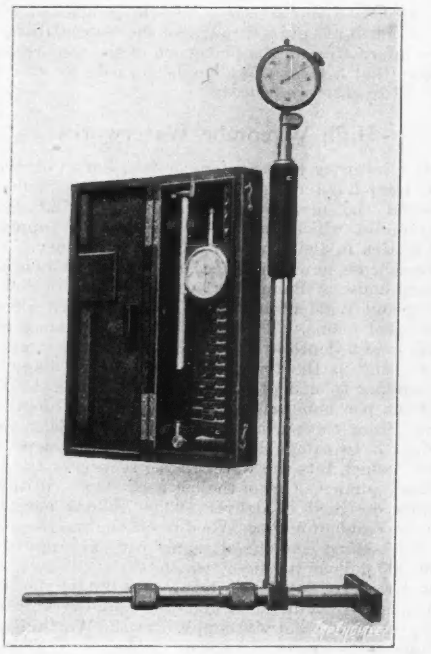


FIG. 29—CYLINDER GAUGE—MERCER

The dial test indicator illustrated in Fig. 28 is for showing the lack of roundness or the excentricity of rotating shafts, &c., for aligning parts of machines, proving parallelism of surfaces, and for many other jobs carried out by fitters and inspectors in engineering workshops.

The cylinder gauge shown in Fig. 29 is designed for testing parallelism, out of roundness, wear, &c., in cylinders from 6in. to 12in. in diameter, and as the dial is always outside the cylinder under test, the reading given by the pointer is easily observed. If the cylinder gauge is calibrated with a micrometer or by applying it to a cylinder of known diameter, it can be used for measuring the actual diameter of cylinder bores. The firm's ship's synchronised chronometer time control equipment occupies a prominent position on the stand. Electrically wound master clocks (as shown in Fig. 30), with full chronometer escapements, and as now fitted to a large number of vessels which do not carry a chronometer, are on view, together with chronographs of the tape and dial types.

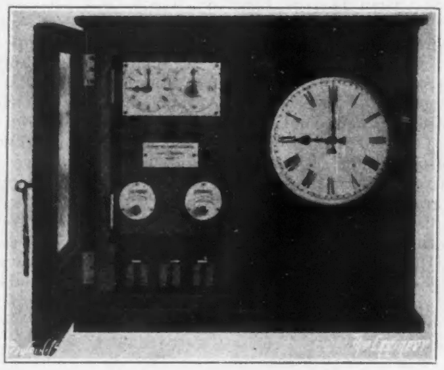


FIG. 30—MASTER CLOCK AND AUTOMATIC CONTROL PANEL—MERCER

AILSA CRAIG, LTD.

The exhibit of marine propelling and electric generating sets shown by Ailsa Craig, Ltd., of Strand-on-the-Green, London, W.4, serves to illustrate the great advance which, during the past few years, has been made by the firm in the design and construction of heavy-oil and paraffin-petrol engines of the smaller powers. They are manufactured in standard units having from one up to eight cylinders, in powers ranging from 6 B.H.P. up to 140 B.H.P. The heavy-oil engines operate on the four-stroke, airless-injection principle, and utilise a compression-ignition system of the Auro type with an air cell in the piston crown, to which the injection nozzle in the cylinder head is inclined at an angle of about 60 deg. The principle adopted was fully described and illustrated in our issue of September 11th, 1931. These Ailsa Craig heavy-oil engines are manufactured in two series, one with a cylinder bore of 3⅞in. and a stroke of 5½in., and the other with a cylinder bore of 4⅛in. and the same 5½in. stroke. They can be supplied either as direct-drive sets, or with standardised reduction and reverse gears of the firm's own design. A constructional feature is the large size of the crank shaft, which, in the case of the 3⅞in. cylinder bore engines, has a diameter of 2⅝in. The main bearings are long, the total length being 8½in. for the two-cylinder model, 14in. for the four-cylinder engine, and 19in. for the six-cylinder unit. The bearings shells are gun-metal, and they are lined under pressure with white metal. Special cast irons and alloy steels are used for the framing and running parts of the engine. The fuel pumps, injectors, and fuel filters are of the Bosch pattern, and the fuel pump is governor-controlled, giving a speed range of 1400 down to 220 r.p.m., according to the position of the hand-control lever. The starting arrangements embody some special features, and although the engines can be equipped with electric starting motors when desired, they can quite readily be started by hand in the smaller sizes especially.

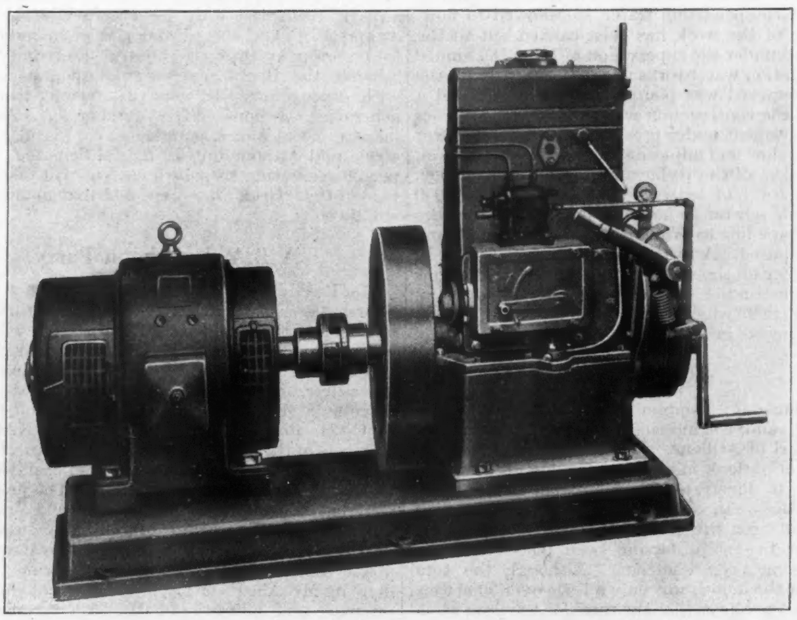


FIG. 31—10-kW OIL ENGINE-DRIVEN GENERATOR SET—AILSA

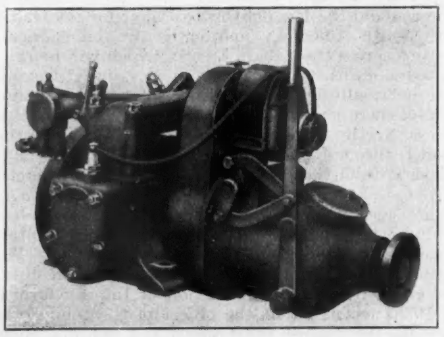


FIG. 32—4-6 B.H.P. MARINE PETROL ENGINE—AILSA

On the side of the valve rocker cover there is arranged a compression release lever, which has three positions, "no compression," "running position," and "over-compression." When it is desired to start the engine, the lever is moved over to "no compression" and the fuel pumps set for full speed. As soon as the engine has been turned over to give the fly-wheel sufficient momentum, the lever is thrown right over to "over-compression," and the valve setting corresponding to this position gives the special high-compression pressure for ensuring a prompt start. The lever is brought back to the normal running position when the engine has run up to speed.

We have chosen for illustration in Fig. 31 a twin-cylinder 12–20 B.H.P. engine mounted on a common bed-plate with a 10 kW generator. This view clearly illustrates the fuel pump, which is mounted on the cam shaft gear-box, and is furnished with an injection advance and retard lever. The lever shown to the right in the inclined position is the hand control for the governor, while the starting handle is also indicated. The engine is fitted with forced lubrication, and has an excentric-driven plunger pump for circulating the cooling water. Another exhibit of interest is the twin-cylinder 4–6 B.H.P. water-cooled, horizontal, opposed-piston petrol engine, illustrated in Fig. 32, which has been specially designed for the propulsion of small boats and for providing auxiliary power in yachts up to 5 tons. This engine has 2⅜in. bore cylinders, with a stroke of 2½in., and is designed for a running speed of 1000 to 2000 r.p.m. The petrol engines shown by the firm include a four-cylinder, 12–20 B.H.P. engine, with a special turbulence combustion chamber in the cylinder head, which has been designed for the utilisation of the cheaper grades of petrol fuel. Alongside the complete engines, some of which are shown in operation, a series of component parts is on view.

LACY-HULBERT AND CO., LTD.

The principal exhibits shown on the stand of Lacy-Hulbert and Co., Ltd., pneumatic engineers, of Boreas Works, Beddington, Surrey, is a series of portable air compressors, including both electric and petrol engine-driven units, along with auxiliary pneumatic equipment and air-operated tools. In the drawing reproduced in Fig. 33 we show a section through one of the firm's latest types of air compressors. It is equipped throughout with ball and roller bearings and is water cooled by means of a hopper and a fan-cooled radiator. The drawing shows the arrangement of running parts and the manner in which the valves are cooled. A compressor of this type is also illustrated in Fig. 34, which shows a modern type of paint spraying plant, or portable compressor unit for the operation of small pneumatic tools. Our engraving shows the unit coupled to a paint container and spraying pistol. The compressor is driven by a 3 H.P. Lister 1250 r.p.m. petrol engine, which is complete with a speed governor, fuel tank, exhaust silencer, and self-contained radiator and fan unit. The lower frame is designed as an air receiver and carries a pressure gauge, a pop safety valve, with drain cocks, and hose connections. The unit is mounted on a pair of strong wire wheels with 26in. by 3½in. Dunlop tires, which facilitate easy transport. A removable draw handle forms part of the equipment and there is a rubber shod foot giving three-point suspension when the unit is standing.

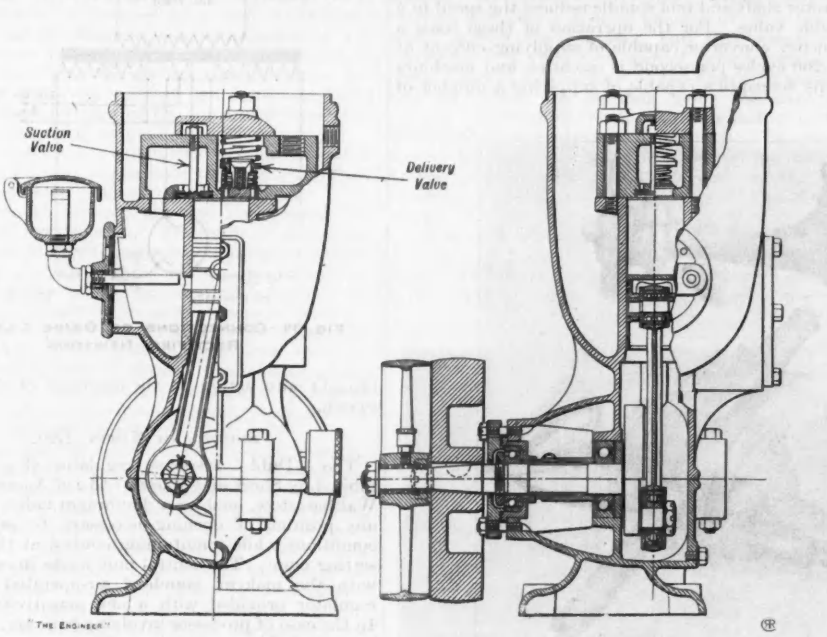


FIG. 33—SECTIONAL DRAWINGS OF SINGLE-CYLINDER COMPRESSOR—LACY-HULBERT

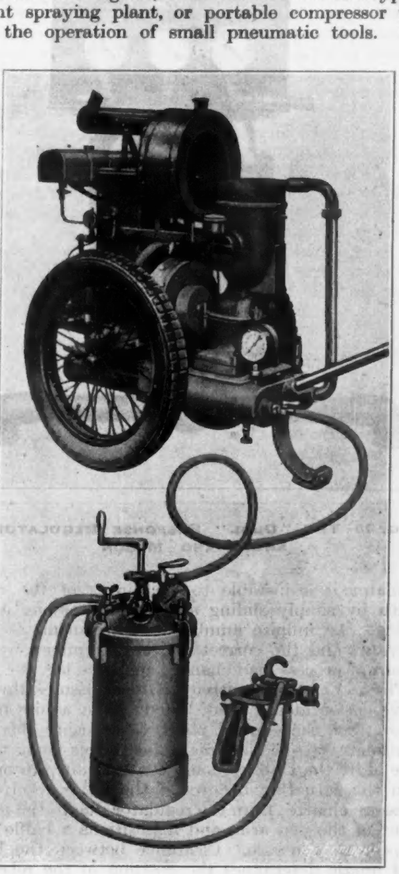


FIG. 34—PAINT SPRAYING EQUIPMENT—LACY-HULBERT

Another recent product of the firm is the small air-cooled compressor illustrated in Fig. 35. In the matter of main bearings and connecting-rod bottom end design it closely follows the design of the unit illustrated in Fig. 33. It has, however, been specially built for a variety of duties, such as tire inflation, thermostatic control, and other similar services which call for a small machine of proved reliability.

At the Exhibition a No. 1 automatically controlled air compressor set, of which there are four sizes, with designed outputs from 3 up to 12 cubic feet capacity, is shown. For such duties the air compressor is driven by a small electric motor and V-shaped belt, an automatic switch and valve gear being provided, which stops the compressor as soon as 130 lb. has been reached and starts it again when the pressure falls to 110 lb. per square inch. The whole of the equipment is mounted over a riveted air receiver of circular shape, which is designed and tested for a working pressure of 300 lb. per square inch and a working pressure of 150 lb. The firm is also showing a range of Boreas patented rotary pumps for lifting circulating water and oil, suds, brine, petrol, &c. It has also worked out a method of tire inflation for garages utilising a high-pressure air receiver at 1800 lb. and parts of this equipment are on view on the stand.

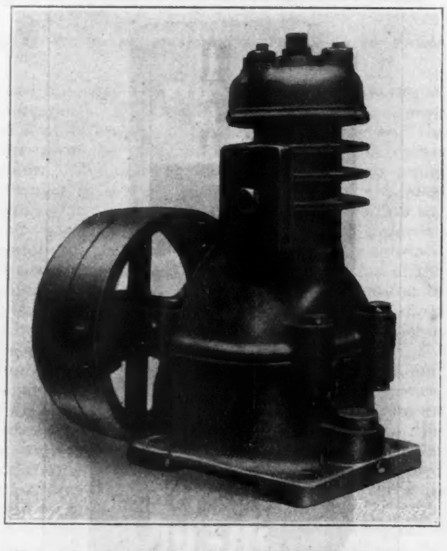


FIG. 35—SMALL AIR-COOLED COMPRESSOR—LACY-HULBERT

SHEEPBRIDGE STOKES CENTRIFUGAL CASTINGS COMPANY, LTD.

Castings in a number of alloy cast irons manufactured by a patented centrifugal casting process are shown by the Sheepbridge Stokes Centrifugal Castings Company, Ltd., of Sheffield, besides many others cast in sand. In making centrifugal castings the firm utilises permanent metal moulds rotating at high speed and no sand is necessary. The castings shown are arranged to demonstrate the properties of the alloys from which they are made, as the firm is particularly concerned with the production of alloys with special qualities, such as resistance to wear, to heat, and to corrosion. Of these alloy cast irons Centricast Mark IV., which is a low-silicon grey iron alloyed with nickel, has a tensile strength of 16 to 22 tons per square inch and a Brinell hardness figure of 275–300 in the as-cast condition. Its special quality is that its wear-resisting properties may be much improved by quenching in oil from a temperature of about 850 deg. Cent. and subsequent tempering in a salt bath, a hardness figure of 450–500 throughout the section being obtainable. The material thus produced is suitable for cylinder liners, valve bodies, gears, bushes, dies and moulds, &c. Another interesting alloy cast iron is known as Hypocrode. Its composition for most purposes is 12 to 15 per cent. nickel, 6 to 7 per cent. copper, and 1·5 to 5 per cent. chromium, and it is essentially austenitic in character. This material may be cast into intricate shapes with an absence of any tendency to porosity and being resistant to erosion and the corrosive action of acids and alkalies, is suitable for hydraulic parts of many kinds, such as pump barrels, plungers, liners, &c. Since it also has a high resistance to distortion under heat conditions and to growth at high temperatures, another field of usefulness is also available, and it may be used for furnace parts, stoker parts, ingot moulds, &c. Such castings are to be seen on the stand. Some of its physical properties as given to us by the makers are shown in the table below.

Tensile strength..	14 to 16 tons per square inch
Elongation	1½ to 2 per cent. on 2in.
Modulus of rigidity	$13–18 \times 10^6$ lb. per square inch
Specific gravity	7·5 to 7·6
Coefficient of thermal expansion	$1·8–1·9 \times 10^{-5}$
Thermal conductivity	0·08
Electrical resistivity	135 to 140 microhms per c.cm.
Temperature coefficient of electrical resistance (0 deg. to 100 deg. Cent.)	0·00045
Magnetic permeability	1·03 to 1·05
Brinell hardness	140 to 300, as required

The firm also manufactures under licence the Silal and Nicrosilal alloys, invented by the British Cast Iron Research Association.

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, LTD.

A comprehensive display of new wireless apparatus, including the latest installations for telegraphy and telephony and music playing, is to be seen on the stand of the Marconi International Marine Communication Company, of Electra House, Victoria Embankment, W.C.2. The exhibits are arranged both to facilitate the examination of apparatus and to indicate the space required for wireless equipment of various kinds on different classes of vessels. The installations are fitted in three cabins, in one of which the most recent of the largest wireless telegraph installations for use on ships is shown. The installation includes a 2 kW transmitter capable of communication on long, medium, and short wavelengths. Switches facilitate the change over from one unit to the other, and connect the appropriate aerial to the transmitter to be used, so that the operator can transmit on any desired wavelength with a minimum amount of trouble. An emergency transmitter as required by international regulations is included in the installation.

In the two smaller cabins there is wireless apparatus for cargo ships, yachts, and trawlers, &c. The installation for cargo ships includes the most recent types of medium and short-wave transmitters which meet the requirements of recent International Conventions. On modern cargo ships the conditions may be very exacting. Not only is an efficient service required on the medium wave band over distances up to 500 or 600 miles, but very long ranges of transmission reception may also be necessary. On account of the fact that the space on these vessels is very limited, the Marconi Company has designed two sets which either work separately or in conjunction with one another. Provided the vessel is fitted with both medium and short-wave transmitters of this type, ranges can be obtained up to 500 or 600 miles on the medium-wave transmitter, and over 3000 miles on the short-wave transmitter. As the receiver incorporated in this transmitter covers a wave band of from 15 m. to 20,000 m., it is suitable for working in conjunction with either transmitter, and apart from the fact that the refinements necessary for passenger service have been omitted, it is similar to that employed on large passenger vessels.

As it is sometimes impossible to employ a skilled operator on trawlers, yachts, tugs, fishing boats, &c., the company has introduced simple and efficient transmitters which can be used for communication by telegraphy or telephony. A skilled operator on craft of this nature is, therefore, not absolutely essential. Designed for single-knob control, the transmitters are said to be capable of withstanding the most strenuous conditions met with on small vessels. A battery driving a small D.C. generator provides the high-tension supply. The receivers, which, like the transmitters, are very robust, cover a waveband of from 100 m. to 2000 m.

Shipowners will no doubt be interested in the Marconi wireless telephone set for communication with the wireless telephone stations established by the Post Office in British waters. The apparatus has been designed for use without an operator on yachts and other small craft on which space is restricted, but larger telephone installations capable of meeting more extensive requirements are, of course, available for other ships. Since the receiving equipment for use with the telephone installations covers all the normal broadcast wavelengths, as well as the special marine telephone wave band, weather reports, news bulletins, and other broadcast information can be obtained in almost any part of the world.

E. Green and Son, Ltd.

Besides a vertical tube economiser consisting of forty-eight tubes 9ft. long, a Foster economiser of twenty-four elements 12ft. long and a cast iron oval tube air heater, the firm of E. Green and Son, Ltd., of Wakefield, is showing an "Eco Minor" dry cleaning machine. The construction of the first-named devices has been often described and to the majority of engineers the general details will be familiar, but the dry cleaning machine, which is manufactured by the firm's subsidiary undertaking, Eco Power, Ltd., of 15, Lincoln's Inn-fields, London, is less well known. It is a compact unit for cleaning clothes and textile materials of all kinds in a non-inflammable solvent. For none of the operations of washing, extracting the solvent, or drying is it necessary to open the doors once the machine has been loaded until the goods are completely dry cleaned and deodorised. Owing to this totally enclosed feature it is possible to recuperate and use the solvent over and over again, the loss which has to be made up occasionally being almost negligible. An interesting feature of the device is that the solvent is not merely non-inflammable, but actually a fire extinguisher. The device may be installed in any shop or building and on board ship.

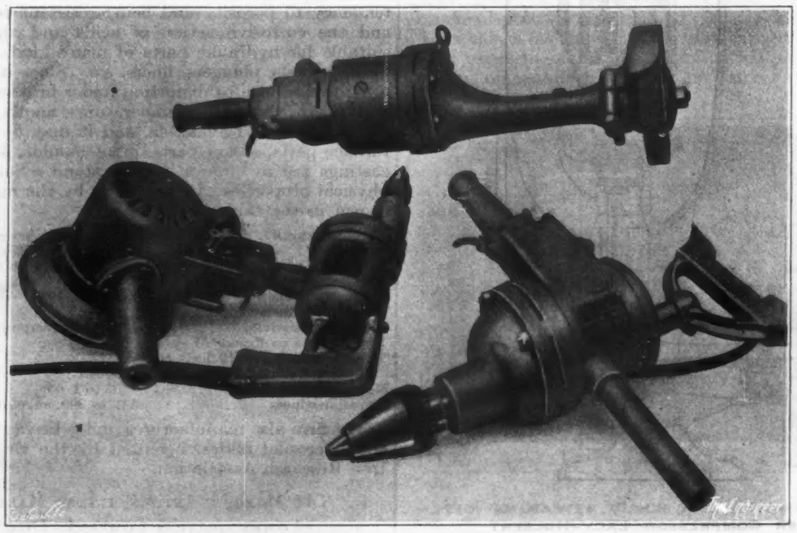


Fig. 36—High Frequency Electric Tools—Newtons

Newtons of Taunton, Ltd.

Electric tools of various kinds, such as drills, grinders, sanders, polishers, valve refacers, &c., are being shown by Newtons of Taunton, Ltd., of 319, Regent-street, W.1. Besides tools fitted with universal motors for A.C. or D.C. and suitable for use on ordinary supply circuits, there are special high-frequency tools, as shown in Fig. 36. The motors fitted to these tools consist of a three-phase field system and a squirrel-cage rotor mounted in ball bearings. The advantages of these tools are greatly increased power, reduced weight, simple construction, and constant speed. The absence of a commutator and brushes eliminates trouble, whilst the greater power-weight ratio facilitates operation and reduces fatigue. The field coils are wound with enamelled and silk-covered wire, whilst the rotor conductors consist of solid copper bars. The rotor is dynamically balanced, and a fan on the shaft serves to ventilate the machine. Gearing between the rotor shaft and tool spindle reduces the speed to a suitable value. For the operation of these tools a frequency converter capable of supplying current at 180–200 cycles per second is essential, and machines of this description capable of supplying a number of tools are made at Taunton, the tools themselves being constructed at the firm's "Rotax" Works, Willesden. At present these high-frequency tools consist of drills, sanders and grinders, but other tools are being developed for reaming, tapping, stud setting, nut driving, &c.

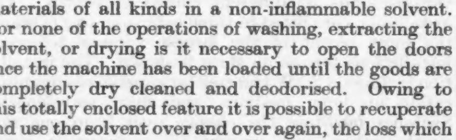


Fig. 37—Oxide Cathode Rectifier—Newtons

Mercury arc and Newton oxide cathode rectifiers, as shown in Figs. 38 and 37 respectively, are also exhibited. The latter is said to be from 25–30 per cent. more efficient than a motor generator and slightly more efficient than the average mercury arc rectifier. Oxide cathode rectifiers are eminently suitable for cinema work. There are no moving parts, ignition, or exciter devices. The average life of the valve is said to be two years and the cost of renewal is considerably less than that of a mercury arc bulb. Exceptionally good voltage regulation is another advantage claimed for these rectifiers. The valve is of the hot cathode gas-filled type, which in its simplest form consists of a filament of barium oxide and two graphite anodes contained in the gas-filled bulb, the filament being heated with A.C. derived from a heating winding on the main transformer, as shown in Fig. 39. As will readily be appreciated by those familiar with rectifiers, the provision of the two anodes enables the apparatus to give full-wave rectification.

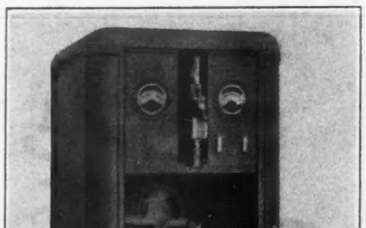


Fig. 38—Mercury Arc Rectifier—Newtons

In the case of the mercury arc rectifier the filament is, of course, replaced by the mercury arc pool, and to start the apparatus an auxiliary arc is formed on the pool in order to establish an electron flow from the mercury to the anodes, this being done by means of an auxiliary exciting circuit, which is automatically brought into action on the operation of the control switch.

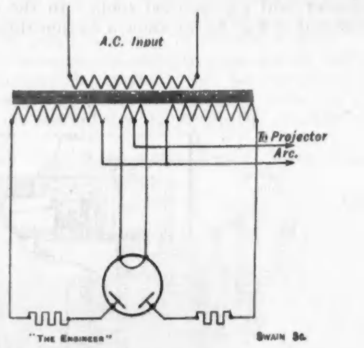


Fig. 39—Connections of Oxide Cathode Rectifier—Newtons

Short and Mason, Ltd.

The "Dubl" response regulator (Fig. 40), exhibited by Short and Mason, Ltd., of Aneroid Works, Walthamstow, enables a diaphragm valve to assume any position of opening necessary to satisfy load conditions while maintaining control at the original setting point. The control unit works in conjunction with the makers' standard air-operated recording regulator provided with a new sensitivity reducer. In the case of processes involving time lag, an instrument with high sensitivity will cause a conventional valve to hunt as the process apparatus cannot absorb changes in the controlled medium as rapidly as the valve responds to the pen movement. The new sensitivity reducer now built into the recording regulator is adjustable to the limits of the chart width by simply sliding a clamp unit along a flat spring. An infinite number of adjustments is thus provided and the correct one is determined by the extent of process load changes and time lag.

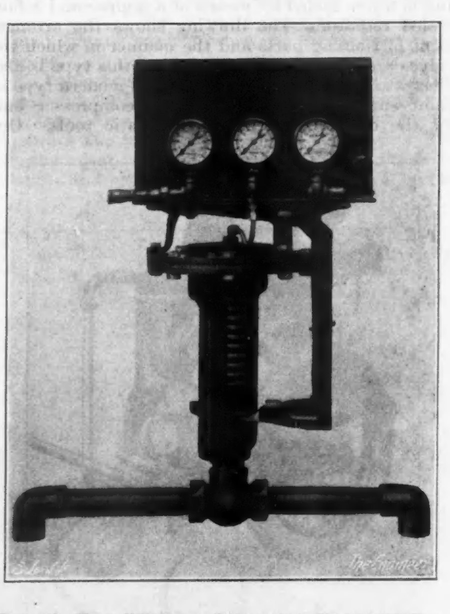


Fig. 40—The "Dubl" Response Regulator—Short and Mason

The use of the sensitivity reducer assures throttle valve action at any load, but does not assure maintenance of the control point when using the conventional type of diaphragm valve, this being taken care of by the Dubl response control unit. In operation the actuating bellows of the latter receive air pressure changes from the regulator due to the movement of the pen arm, and it positions a baffle with respect to a nozzle. Clearance between the baffle and nozzle determines the position of the relay air valve and therefore the air pressure admitted to the diaphragm valve. Increased pressure drives the valve stem downwards and the push rod upwards. At its lower end the push rod is attached to a pivoted lever in contact with the valve stem just above the stuffing-box and at the upper end to the nozzle blocks. Responsive movement of the valve stem is therefore exactly proportional to the baffle movement, since it must continue until the baffle-nozzle clearance is correct. This is the initial valve response operation, and is proportional to the movement of the pen arm from the control setting. By the time the process has begun to take advantage of the initial valve movement a second response action is started by the Dubl response mechanism.

This action is independent of the pen arm position. It is associated with the damping device, and the pivoted levers connected to the baffles, and determines the final position of the valve within extremely fine limits. The damping device consists of bellows filled with liquid, and is adjustable to match the approximate time lag of the process, or, in other words, the delay between the change in input of the controlled medium and the response of the regulator. The damping device is arranged on a slide so that the magnitude of the damping can be adjusted on site to synchronise with the time lag and load change in the same way that the sliding clamp unit in the pneumatic sensitivity reducer can be synchronised with the characteristics of the apparatus concerned to give full throttling action.

Another exhibit is a volumetric pressure recorder, which resembles in appearance the firm's standard mercury operated recording thermometer. The major difference between the two instruments lies in the bulb construction. The bulb of the volumetric pressure recorder responds to pressure instead of temperature, and the principle involved therefore differs from that of the temperature recorder. In addition to the bulb or pressure responsive element, the power unit or tube system consists of the connecting tubing and a hardened fine bore steel Bourdon spring welded together to form a hermetically sealed system, which, except for the space in the bulb occupied by a special alloy temperature compensating element, is filled with mercury.

When the bulb is subjected to external pressure, its volume is reduced as the applied pressure increases, and some of the mercury it contains is forced into the tubing, and so causes the Bourdon spring to uncoil. Conversely, when the pressure on the bulb is reduced, its increased volume permits mercury to flow back into it, and the Bourdon tube returns to its original position. Instead of the operation of the Bourdon spring being caused by the increased volume of mercury due to its expansion under the influence of heat, the operation of the spring is caused by displacement of the mercury from the bulb as a result of the change in its dimensions under the influence of pressure. On account of the temperature compensation employed, the volumetric pressure recorder only responds to changes in pressure around the bulb. By means of the special alloy compensating element inserted in the bulb, the difference of expansion of the bulb equals the expansion of the mercury produced by temperature; whilst the temperature effect of the remaining part of the system is compensated for in the usual way by means of a bimetallic compensator. The principle of operation lends itself to the measurement of high pressures under conditions which make the conventional type of Bourdon gauge inapplicable.

The makers inform us that owing to the pulsation-proof operation and the fact that the liquid under test does not enter the Bourdon spring, the instrument, which can either indicate or record the pressure at a remote point, has so far found the widest field of application on homogenisers which demand in general a pressure range of 0–5000 lb. The same principle has been incorporated in a tension type of bulb, which finds application where a cable or other tension load has to be recorded or indicated.

HYDRAULIC COUPLING AND ENGINEERING COMPANY, LTD.

Hydraulic couplings have become familiar to the public by reason of their use upon motor cars, but in actual fact their applications are far less limited than that. To those interested in such devices a visit to the stand of the Hydraulic Coupling and Engineering Company, Ltd., of Worton-road, Isleworth, can be recommended. A photograph of a Vulcan-Sinclair traction-type coupling, showing the main parts, is reproduced in Fig. 41. The majority of our readers will be more or less familiar with its mode of operation. The oil contained within it is constrained to follow a helical path between the "pockets" of the two halves, and in this manner transmits the drive. Actually, the driven shaft may be completely stalled without causing the driving motor or engine to stop. Under such conditions the full torque is transmitted. At full speed and full load a slip equivalent to about 2 per cent. occurs. As we have already said, the use of hydraulic couplings in the traction field is already fairly well known. But with slight modifications it is also particularly suitable for other applications. When used for traction purposes a definite amount of oil is usually sealed within the coupling, and this quantity is invariable. If, however, special arrangements are made whereby the amount of the hydraulic medium may be varied, the coupling gains characteristics of very considerable value for such duties as the driving of centrifugal pumps and fans, &c. In general, it may be said that boiler feed pumps are usually driven by direct-coupled A.C. electric motors. The arrangement has certain disadvantages. The characteristic of a centrifugal pump running at constant speed is such that should it at maximum output develop just sufficient pressure to overcome that within the boiler, it will at lower deliveries develop a considerably higher pressure. Thereby there is caused not only a waste of power in overcoming an unnecessarily high pressure, but, also, the pipe work feed heaters and valves between the pump and the boiler must be designed to withstand the excess pressure. By coupling the motor and the pump hydraulically a much closer approach to the ideal condition at which the pressure at discharge into the boiler is constant can be obtained. In order to maintain the pressure of delivery at the boiler constant it is necessary to reduce the speed of rotation of the pump. At the same time, the speed of rotation of the A.C. motor must remain constant. This effect can be achieved by altering the amount of oil within the coupling according to the load on the pump.

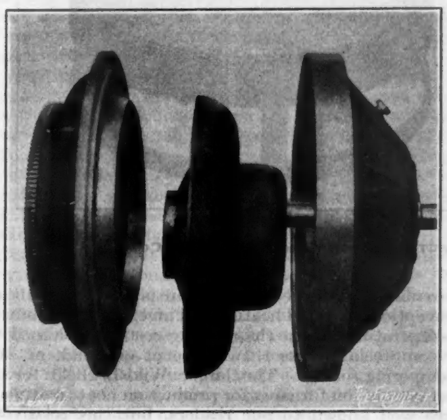


FIG. 41—VULCAN-SINCLAIR HYDRAULIC COUPLING

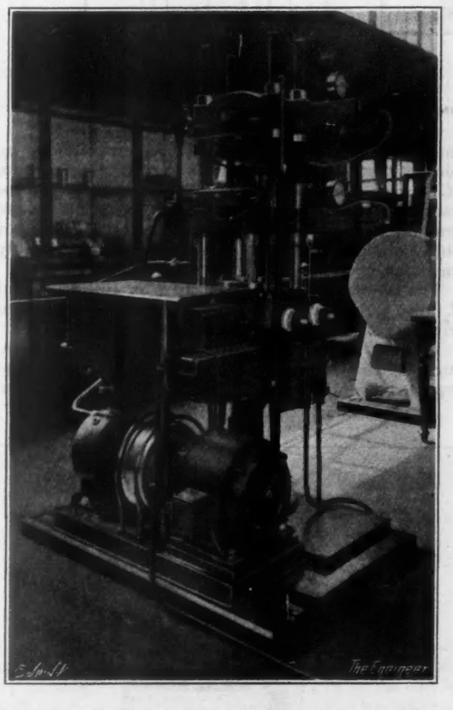


FIG. 42—COUPLING APPLIED TO HYDRAULIC PRESS

For the purpose of driving boiler feed pumps and also fans, which have very similar characteristics, the oil for the coupling is made to circulate from an overhead tank. It runs down by gravity to the coupling and is "scooped" out and returned to the tank through a separate pipe. As applied to feed pumps, there is an automatic regulating valve in the oil supply pipe. When the feed pressure tends to rise, owing to the boilers requiring less water, a servo-cylinder operated by the feed pressure partially closes the regulating valve, thereby partially starving the coupling of oil. The slip, therefore, increases and the pump speed is reduced, although the motor speed remains constant. Thus the pressure may be maintained very nearly constant. Since pressure oil for the operation of the servo device can be obtained from the scoop tube, the set may be self-contained.

Another application of the coupling is illustrated in Fig. 42. Here it is interposed between a motor and a positive rotary pump supplying oil for the operation of a hydraulic press for bakelite and similar plastic substances. The operation of such presses demands a considerable period during which the pressure is maintained without any motion. Thus during the first stage, when the material is being forced into the die, the coupling acts with little slip, and the pump is rotating at nearly the same speed as the motor, and during the second stage, the pump is almost or completely stalled, the slip becomes 100 per cent., and by reason of the characteristic of the coupling the pressure is maintained.

F. J. EDWARDS, LTD.

Among the newer sheet-metal working machines exhibited by F. J. Edwards, Ltd., of 406, Euston-road, London, N.W.1, there are the angle bender and the cramp folding machines illustrated by Figs. 43 and 44.

The former, it will be seen, is of the hand-operated type, and its top beam is pivoted at one end, while the other end is held by a square notch. As a consequence, it can be swung out and any enclosed form which has been bent around it can be slipped off endways without deformation. The beam is locked in position by a pin, while the bending is being done. An adjustable back gauge is provided for repetition work, and the end frames have openings so that long, narrow strips of metal can be fed through and formed by the length of the table at each stroke. The machine is made in several sizes with widths ranging from 20½in. up to 48½in., and is intended for working mild steel sheets of from 20 to 18 gauge. The cramp folding machine (see Fig. 44) is so arranged that the work can be passed right through the gap between the clamping beams, so that bends can be made at any part of the length of the sheet as well as the edges. Gauges are provided for locating the sheet when bending narrow edges, but they can be removed when longer folds are required. The top beam can be lifted clear by means of an excentric shaft to allow bent or shaped sheets to be inserted, and the front (bending) beam is provided with a stop to ensure the angle of the bend being repeated. The corner can be made either sharp or with a radius. The machine is made in five sizes for sheets from 26in. to 48½in. wide.

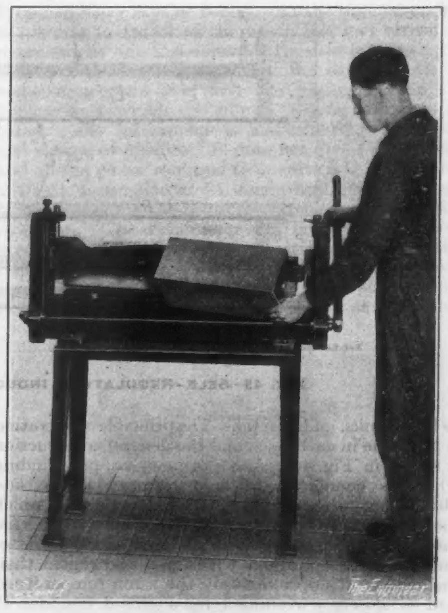


FIG. 43—SHEET METAL BENDER—EDWARDS

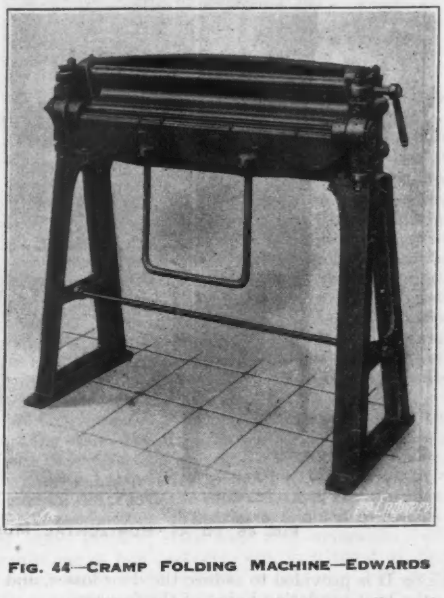


FIG. 44—CRAMP FOLDING MACHINE—EDWARDS

ELECTRIC RESISTANCE FURNACE COMPANY, LTD.

Self-regulating normal frequency induction furnaces for heat treatment and low-temperature metal melting are shown by the Electric Resistance Furnace Company, Ltd., of 17, Victoria-street, S.W.1. The temperature is controlled by bars composed of a special alloy supplied for maintaining the furnace temperature at any value between 400–1000 deg. Cent. When the desired temperature is reached these bars lose their magnetism, and the input to the furnace is immediately diminished, until the bars regain their magnetism, when the load is automatically increased.

Four types of these furnaces are available: (1) Muffle furnaces for general heat treatment purposes; (2) low-temperature melting furnaces for aluminium, lead, type metal, &c.; (3) balanced furnaces for precision heat treatment of press tools, &c., and (4) continuous heating furnaces for small objects such as bolts, links, gudgeon pins. The principle of operation is the same in each case, and the general construction is shown in Fig. 45. A is a primary copper winding which is connected to any ordinary low-tension alternating current supply; B a magnetic core, which may constitute the furnace muffle, or may be inserted into the muffle in the form of bars. It is made of one of a series of alloys which lose and regain their magnetism at approximately the same temperature, and is closely surrounded by a closed cylinder C, which is substantially non-magnetic at the working temperature. B^1 is a laminated iron core which completes the magnetic circuit. A heat-insulating lining D is provided to reduce the door losses, and E is the heat-insulating lining of the furnace.

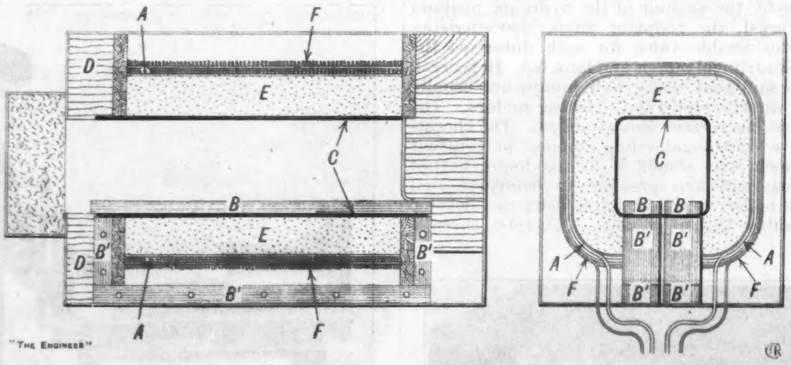


FIG. 45—SELF-REGULATING INDUCTION FURNACE—E. R. FURNACE CO.

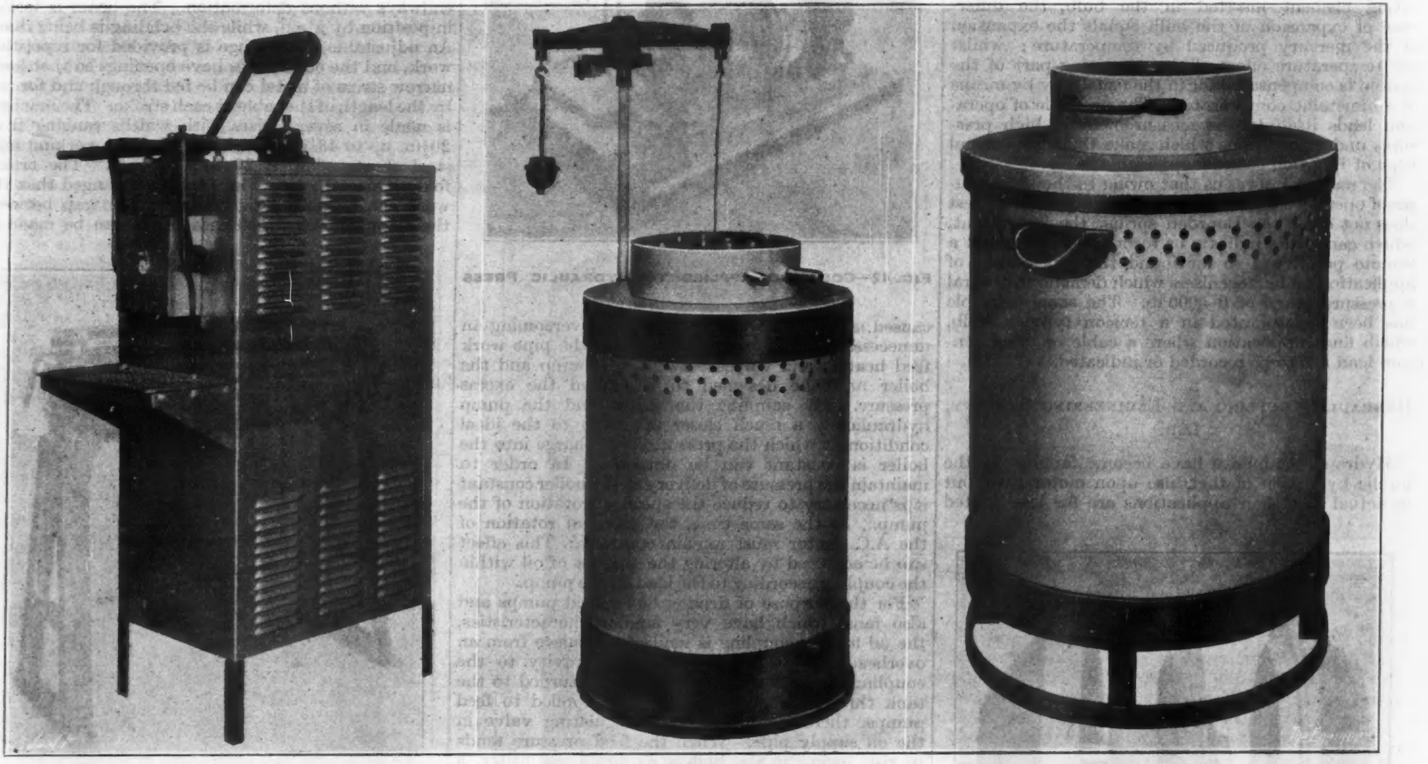


FIG. 46 TO 48—HORIZONTAL MUFFLE, VERTICAL MUFFLE, AND CRUCIBLE FURNACES—ELECTRIC RESISTANCE FURNACE CO.

The coil A acts as the primary of a transformer, of which the cylinder C is the short-circuited secondary and B and B^1 the core. Current induced in the cylinder C causes it to be heated, and the heat passes by conduction to B, which, at a certain temperature, loses its magnetism. This reduces the flux through the core to such an extent that insufficient heat is generated in the cylinder C to compensate for the losses by radiation, &c., and the temperature of B accordingly falls until it reaches the point at which it regains its magnetism. The induced current then increases and the temperature of the cylinder C again begins to rise, the small amount of heat generated in B by eddy currents being insufficient to interfere with the cycle described above. In some cases an additional copper coil F and a condenser are provided for power factor correction, but, generally speaking, these are unnecessary. As there is only a small difference of temperature between the points at which the ferro-magnetic material loses and regains its magnetism, the control of temperature is very close.

Furnaces constructed on this principle are claimed to possess many important advantages as compared with resistance furnaces heated by elements of nickel chrome or other similar alloys. The temperature remains practically constant without the use of any control instruments, and as the muffles are made of special steels instead of refractory material, the furnaces are very robust. Short circuits by contact between the charge and the resistors are, of course, eliminated. The rate of heating can be varied within wide limits, and as the variations are gradual instead of instantaneous, the load is not objectionable from the point of view of supply undertakings.

The power factor is about 0·8 on full load, but if unity power factor is required, it can be obtained with a condenser connected to the coil F.

When it is desired to change the working temperature of the furnace, the self-regulating bars are replaced by others of different composition. Regulator bars in different parts of the furnace can have a different composition in order to provide a predetermined variation of temperature along the length of the muffle in order to meet the requirements of heat treatment operations. The makers also explain that it is impossible for a furnace to "run away," owing to failure of control gear, and so damage the charge that is being heat treated.

A self-regulating horizontal muffle furnace for tool hardening and general work is shown in Fig. 46, and a vertical muffle furnace in which the charge to be treated is suspended on one arm of a simple balance in Fig. 47. The charge in this case must be magnetic, and use is made of its magnetic change point. When this point is reached the attractive force is removed and the out-of-balance condition causes the charge to move upwards in the furnace, and a small switch on the arm closes an alarm circuit. The self-regulating elements consist in this case of a hollow cylinder or a number of bars placed inside the secondary conducting muffle, and retained in position by a cylinder of non-magnetic material. In addition to simple heat treatment processes these vertical muffle furnaces are suitable for precision processes. Fig. 48 shows a 5 kW crucible furnace for melting lead, aluminium, &c.

WILD BARFIELD ELECTRIC FURNACES, LTD.

Among the exhibits of Wild Barfield Electric Furnaces, Ltd., of Elcfurn Works, North-road, Holloway, N.7, is a new tool-room tempering equipment, as shown in Fig. 49. Air is circulated by a centrifugal fan in a closed circuit over the heating elements, and through the work under treatment, so that the heat is conveyed from the source to the charge much more rapidly and with greater uniformity than would be possible with still air. The powerful circulation produced by the fan is said to result in exceptionally rapid heating and an extremely uniform temperature, whilst the running costs are claimed to be appreciably less than those of oil, lead, or salt tempering baths. The larger Wild-Barfield forced air circulation furnaces for production heat treatment are well known to our readers, but this relatively small furnace has been introduced to meet the demand for an equipment suitable for tempering carbon and alloy steels, and the secondary hardening of high-speed steel tools in the tool-room.

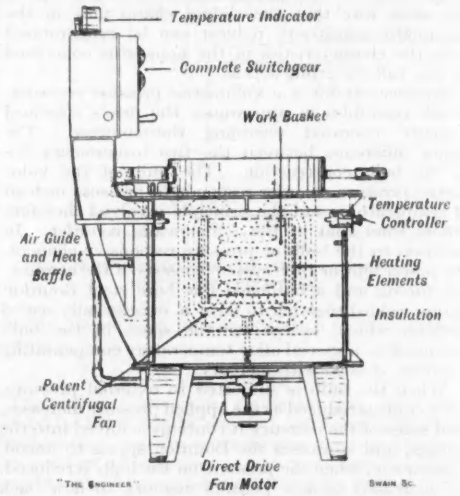


FIG. 49—TOOL-TEMPERING EQUIPMENT—WILD BARFIELD

While compact, and occupying little floor space, the furnace is equipped with automatic temperature control gear, a temperature-indicating instrument, and a switch panel fitted with pilot lights. Refinements, such as the charge progress recorder, as fitted to the larger production furnaces, are not, however, provided as standard accessories, as they are not essential for ordinary tool-room work. The new furnace is made in two types, one suitable for temperatures up to 400 deg. Cent., and the other up to 650 deg. As far as the construction is concerned, both furnaces are identical, the only difference in the two being the design of the temperature regulator. While the low-temperature model is suitable for tempering carbon steel parts, the high-temperature unit will cover the whole range of tool-room tempering. The maximum rating is 4 kW, but a consumption of 1½ units per hour serves to maintain the temperature at the highest value.

In order to combine rapid initial heating with close temperature control, a switch on the control panel serves for cutting out one section of the heating elements, and by thus reducing the furnace rating exceptionally close control is said to be secured even at temperatures extending down to 200 deg. Cent. The most expensive dies, press tools, milling cutters, &c., can be treated without risk of damage. In the design of these equipments the utmost simplicity has been aimed at. All connections between the furnace and its associated electrical gear are made at the works, and after the user has connected up the supply leads to the switch panel, the furnace is ready for use.

The Walter Kidde Company, Ltd.

Two types of fire-detecting equipment for ships are exhibited by the Walter Kidde Company, Ltd., of Hanwell, London. The two systems are known as the "Selex" and the "Zonit" respectively, and differ in the respect that while the first gives an indication on the bridge or in a separate fire station of the exact location of the fire, the latter only indicates the "zone" in which the fire has occurred. For the actual detection of the fire, thermostatic switches, operated by Grinnell quartz bulbs, are used. These quartz bulbs, it will be remembered, enclose a quantity of a special non-freezing non-corrosive liquid, and at normal temperatures a small bubble of air. As the temperature rises the air bubble is compressed until finally, on its complete disappearance, the pressure becomes great enough to shatter the bulb. In the fire-detecting systems under review, this occurrence causes electric contacts to open or to close.

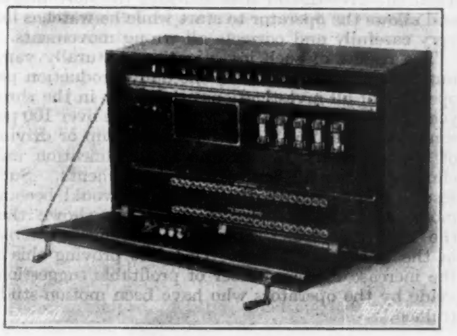


Fig. 50—"Zonit" Fire Detector—Kidde

These units are common to both "Zonit" and "Selex" systems, the former of which, owing to its greater simplicity, will be described first. In this system a number of thermostats are connected in series. For instance, in each of a group of cabins situated close to one another, there would be one thermostat. All the units would be connected in series, the wire beginning and ending at the control cabinet on the bridge. There would be several separate circuits, one for each zone. In passageways and gangways a manual alarm, operated by the breakage of glass, could be substituted for the automatic thermostat.

On the occurrence of a fire in any cabin, the thermostat operates to break the circuit and causes a relay in the control cabin to operate. A gong is then rung and continues to ring until attention is paid to it. To discover the zone in which the fire is situated, the front of the cabinet is opened, as shown in Fig. 50, and all the switches in the top row are depressed. This action causes the gong to cease ringing, since alternative circuits to those provided *via* the thermostats are then put in action. The switches are next raised one by one. Only those which cause the gong to ring when raised are left in the lowered position. These switches indicate the zone or zones that must be examined for the fire. Closing the door of the cabinet automatically raises all the switches.

It will be appreciated that should an "earth" occur, the whole system might be made inoperative. To guard against any such happening, a "buzzer" is arranged to sound if there is an "earth" in any circuit. Then by operation of the lower row of switches, the circuit thus affected can be discovered and the fault subsequently rectified. The "buzzer" also sounds should any other trouble occur. For testing the circuits there is in each a test station containing a switch which may be opened by the operation of a key. The resulting action is exactly that occurring if a thermostat operates.

The "Selex" system is wired differently, and usually there are also two types of thermostat. The "selector" thermostats, which, on the bursting of the quartz bulb "make" a contact, are arranged across a two-wire system. In series with each there is a fixed resistance. "Non-selector" thermostats may be wired across "selectors." In this way the operation of a non-selector thermostat may be made to have the same result as the operation of the "selector." The two wires of the system are also connected by a large resistance. Altogether, each zone of the system may have a total of 49 "selector" thermostats. Thus with ten zones 490 cabins or rooms could be protected.

Normally a "trickle" of current limited by the resistance across the circuit is passing. On the operation of a thermostat, however, a considerably larger current flows. Its first action is to set ringing a gong in the control cabinet. At the same time a relay is set in motion and rotates a selector switch which brings into action in the internal circuit of the cabinet a resistance large enough to balance that of the external circuit. By this action there is set up on the central panel, to be seen in the engraving, Fig. 51, a key number for the position of the thermostat operating the circuit. Opening the cabinet door stops the ringing of the gong, but the key number is still displayed.

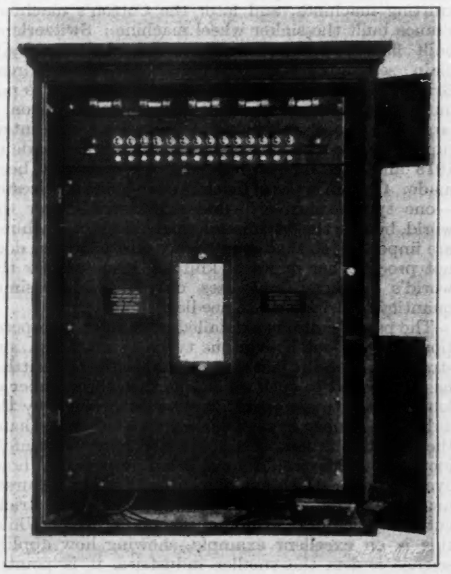


Fig. 51—"Selex" Fire Detector—Kidde

Both the "Selex" and the "Zonit" systems derive their electric current from the ship's supply, and, in addition, there are also accumulators capable, by themselves, of keeping the system in action for two days, and "trickle" charged from the mains.

Telephone Manufacturing Company, Ltd.

Noise proof telephones for use in ships, engine-rooms, and, in fact, in all places in which noise precludes the use of ordinary telephones, are being exhibited by the Telephone Manufacturing Company, of Hollingsworth Works, West Dulwich, S.E.21. There are also loud-speaking instruments of the horn and hand combination type and auxiliary apparatus, such as indicators, switches, plugs, sockets, &c. To prove the claim that ships' telephones can be used in very noisy places, a special cabinet has been erected on the stand to enable visitors to test the instruments under that condition. Other exhibits consist of inter-communicating telephones for use in offices and works and A.C. and battery operated synchronous clocks.

Black and Decker, Ltd.

A good display of portable electric tools is to be seen on the stand of Black and Decker, of Slough. There are drills ranging from ¼in. to 1¼in. capacity in steel, together with bench and post drill stands, portable electric screw drivers, and nut runners for driving screws into wood or metal, and for running on nuts respectively, portable electric sanders for sanding castings, &c., for cleaning welding seams, and for sanding and polishing boat hulls, car bodies, &c., previous to varnishing and enamelling. Other exhibits consist of portable electric grinders for fettling castings and forgings, electric buffers, valve refacers, and a collection of high-cycle electric tools. A high-cycle nut runner is shown in operation, and serves to demonstrate that these high-frequency tools are exceptionally light for their rated power. With the aid of a high-frequency nut runner every nut is made uniformly tight without the subsequent use of a spanner, and a special "quick-change" chuck makes it possible to use the same machine for nuts of various sizes with a minimum loss of time. When necessary, these nut runners can be provided with a reversing switch to enable the tool to be used to unscrew nuts, when, for example, machines are dismantled for shipment. Ball bearings are fitted throughout and the gears are composed of specially heat-treated steel. The machines are fitted with a positive clutch which disengages when the forward pressure on the tool is relieved. The motors are small, three-phase, squirrel-cage machines without a commutator or brushes, and are consequently very robust. A small motor generator on the stand converts the standard 50-cycle current into 180-cycle current for operating these tools.

The Marconi Sounding Device Company, Ltd.

Examples of the Marconi Echometer sounding device, as shown in Fig. 52, are being exhibited by the Marconi Sounding Device Company, Ltd., of Electra House, Victoria Embankment, W.C.2. By means of these instruments a ship is able to send out through the water to the sea bed a series of focussed high-frequency rays or beams, and the time taken for the beams to travel to the ocean bed and return is measured by the instrument. By merely pressing a button the navigator is shown the exact depth of water under the keel and the nature of the sea bottom over which the ship is passing is also indicated. The instrument is instantaneous in action and simple to operate. It does not give rise to noise and all the power required to operate it is taken from a 4-volt accumulator. A single hull casting serves to accommodate the projector, which is also used for reception. The Echometer can be operated simultaneously with the wireless direction finder without causing interference, and the projector, which is only about 1ft. in diameter, never requires adjustment. Echometer sounding devices are shown at the Exhibition with ranges of 720, 360, 160, 90, and 30 fathoms.

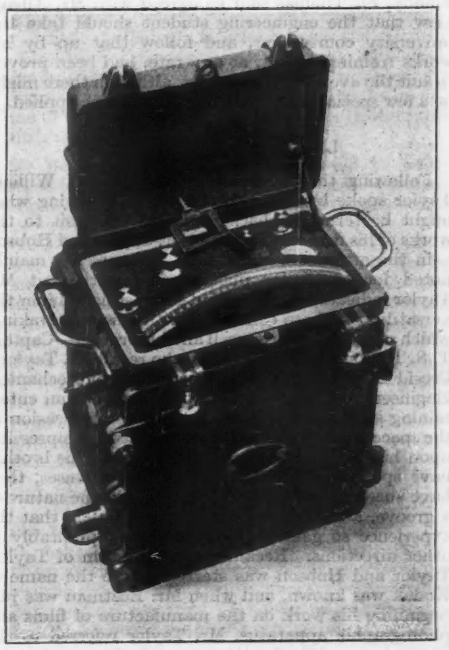


Fig. 52—"Echometer" Sounding Device—Marconi

The deep sea instrument, reading up to 720 fathoms, is fitted in halibut-fishing craft and whaling vessels. When fishing halibut banks, such as those off the Greenland coast, the Echometer enables the skipper of a line boat to place his lines (often 12 miles long) at the exact depth at which experience has taught him the finest halibut will be found; while whaling fleets make use of the instrument in order to carry out their operations in the vicinity of the deep-sea banks where whales feed. With the standard Echometer provided with a 360-fathom scale, the trawl skipper is able to trawl on the edge of a bank with ease and precision, and to discover those hollows and depressions in the sea bed where the most sought after fish are known to congregate.

With a standard Echometer fitted with a 160-fathom scale, the navigator of a full-powered sea-going passenger ship proceeding at full speed has only to press a button and glance at the instrument to ascertain the true depth under the keel and the nature of the sea bottom. Thus he is enabled to navigate by chart position with ease and confidence under conditions of low visibility, and is relieved of much mental strain when bringing a ship into port in unfavourable weather.

For coastwise shipping and smaller fishing craft there is a 90-fathom Echometer, which, in addition to giving depths under the keel and locating in terms of direction and distance objects on the sea bed, such as rocks, reefs, and wrecks, also indicates by mid-water echoes, the presence of shoals of fish.

The smallest instrument made is designed for rapid and accurate surveys of shallow waters, such as harbours, rivers, estuaries, and canals.

(To be continued.)

An industry with a capital of some £500,000 is being organised in Saghalien, by Japanese interests, for the canning of sardines.

The British Association.

No. I.

Before giving his Presidential Address to Section G (Engineering) on Thursday morning, September 7th, Mr. R. W. Allen paid a tribute to the Recorder of the Section (Mr. J. S. Wilson) for the interesting programme he had prepared for the Section during the meeting, despite many disappointments.

We gave extracts from Mr. Allen's address on page 236 of our last issue.

The vote of thanks to the President was moved by Sir Thomas Hudson-Beare, who said that two outstanding points arose from the address. The first was that engineers should not neglect the history of their profession. At the present time too much attention was paid to the doings of the politician, the soldier and the sailor, and too little to the doings of the engineer, who had transformed civilisation. The second was the reference to the oil engine and its extraordinary adaptability. His great regret, said Sir Thomas, was that the oil necessary for the internal combustion engine is not yet available in our own country. Fortunately, there was good reason to believe that the problem of obtaining oil from coal had been solved technically, and it was now only a question of making it an economic proposition. Finally, Sir Thomas said he agreed with Mr. Allen's view that the engineering student should take the university course first, and follow that up by his works training. That, at any rate, had been proved to suit the average student best, although there might be a few special cases in which the converse applied.

Lenses and Golf Balls.

Following the Presidential Address, Mr. William Taylor spoke briefly with the object of giving what might be termed a background to the visit to the works of his firm—Messrs. Taylor, Taylor and Hobson—in the afternoon. This firm, of course, is mainly noted for lenses for photographic work, but Mr. Taylor indicated in a brief but interesting manner the versatility of those connected with this undertaking, which was started by himself and his brother—Captain T. S. Taylor—in 1887. Those who recall Mr. Taylor's Presidential Address to the Institution of Mechanical Engineers last session will appreciate what an entertaining speaker he is, and on the present occasion in the space of a few minutes he succeeded in impressing upon his audience that, although he and his brother have specialised in the manufacture of lenses, they have succeeded in avoiding anything in the nature of a groove, and that their minds are so alert that the experience so gained has been turned profitably in other directions. Recalling that the firm of Taylor, Taylor and Hobson was started before the name of Kodak was known, and when Mr. Eastman was just beginning his work on the manufacture of films and photographic apparatus, Mr. Taylor referred to the original aim of the brothers to make lenses on something like an interchangeable basis at a time when skilled craftsmen were able to make lenses by hand with an accuracy within one or two wave lengths of light. Paying a tribute to what he had learned in America, Mr. Taylor said his firm now makes some 240 different sizes and kinds of lenses, which require the stocking of 2500 different components, all of which are made interchangeable. Among these are the screws which are commonly used for attaching the elements in the lenses, and for which up to the present no better method has been found, despite its awful imperfections. As a result, methods of generating and gauging screws have been developed which he claimed to be the origin of almost all that is known to-day in the metrology of screw threads. There are also manufactured at the Leicester works of the firm a heterogeneous collection of products which have been forced upon the firm in the processes of lens making, because they could not be obtained outside. For instance, there is the engraving machine for doing work previously done by hand by men "who were not always available on a Monday morning," and at considerable expense. The engraving machine turned out by the firm was the first commercial proposition of its kind—although engraving of the same nature was previously done by Cooke's the lens makers—and many thousands of Taylors' machines are now in use all over the world. Another detail is the pantograph developed by the firm, and now used largely for the marking of cutlery, replacing acid engraving. This consists of a small electrode, vibrating at about 100 times per second, striking and re-making a small arc about the point of the pantograph, automatic means being provided to take care of the wearing away of the electrode and to maintain contact. Again, there has been developed a form of tubular cutter for lens blanks which has been applied to such purposes as the cutting of circular glasses for ships' porthole windows. Finally, Mr. Taylor, again paying a tribute to what he has learned from America, referred to the modern golf ball, and told how, as the result of taking up golf in America, he noticed that the embossed markings on the early types of ball led to fracture, with the result that his firm devised the first means for moulding gutta-percha-covered rubber balls with recessed marking, which machines are now used in many parts of the world.

Knitting.

The remainder of the morning of Thursday, September 7th, in Section G was taken up by a paper by Mr. John Chamberlain on "The Mechanisation of Knitting." It was pointed out that historians have undoubted proof that the art of weaving was practised by the Chinese in 3000 b.c., but the earliest date assigned to the production of knitting is the fifth century a.d. The first knitting machine was invented by the Rev. William Lee, of Calverton, Notts., in 1589. Whilst a triumph of mechanical ingenuity, it was of necessity crude and many scientific developments were required. Many types of machines were introduced in the nineteenth century, but, unfortunately, although the primary inventions were of British origin, many of them were developed in other countries. Germany built flat machines and warp knitting machines, and later the Cotton's machine. France built the sinker wheel machine; Switzerland built flat machines; and the United States built plain seamless hose machines. Although Great Britain made a large variety of machines, it was not until 1914 that attempts at mass production on a large scale were undertaken. Operations were interrupted by the war, but renewed efforts were made in 1918 and since then a great deal of progress has been made. Certain types of machines are built in Leicester—one type exclusively—and exported all over the world, but, on the other hand, many kinds of machines are imported, so that even to-day Great Britain does not produce her quota of knitting machines for the world's markets, and uses only an infinitesimal quantity of British-made needles.

The paper contains a detailed account of the operations carried out by various types of machines, and stress is laid on the fact that mechanisation of knitting has proceeded to such an extent that the number of loops that a single operator can now produce by the aid of machinery is over 3,000,000, whereas by hand the number is less than 300, per hour—a tenfold increase. This would have been impossible, however, but for the development of highly accurate machine tools, such as milling machines, trick-cutting machines, grinding machines, &c. Whilst this is an excellent example, showing how applied science assists the smaller industries, it is pointed out that the amount of research of a commercial character in the knitting industry has been exceedingly limited. The author suggests that this is probably due to the fact that at present it is more remunerative to invent than to research. As hundreds of patents are taken out yearly, however, and as many British builders spend thousands of pounds sterling on experimenting, further mechanisation of knitting is likely. Nevertheless, at present the method is inevitably that of "trial and error." Few machines have even a revolution counter, none have tension meters, adjustments for knitting various yarns are quite arbitrary, and no one knows the relationship between stitches per unit of length of yarn and courses per length of fabric. No one expects to get uniform weight per length, and hose of uniform length is unknown.

The President, opening the discussion on the paper, said that those who had hitherto been only familiar with the products of knitting machinery would have been impressed by the ingenuity of the machines, as described and illustrated by the author.

Mr. Percy Bentley remarked that some years ago he came into this industry as an engineer, knowing nothing about it, but with the help of the author and men like Professor Hele-Shaw, it had been possible to develop the knitting industry from an engineering point of view, to such a state of perfection that machines could be reproduced which could be sold with a guarantee of performance.

Mr. J. S. Wilson (Recorder, Section G) referred to the standardisation of product and commented on the author's reference to "trial and error" results.

Mr. Chamberlain replied that these difficulties were introduced by the varying character of the yarn used, adding that there was a much greater variation in those raw materials than there was in engineering raw materials. Difficulties were also introduced through changes of fashion and the attempt so often made to use the same machines, without modification, on cotton, artificial silk, or wool.

Motion Study.

In Section J (Psychology), on Thursday, September 7th, Miss A. G. Shaw (chief supervisor of women and motion study investigator of Metropolitan-Vickers) gave an address on "Motion Study Applied to Small Assembly and Machine Work." The study is concerned with the assembly of small electrical meters and instruments, and most of the operators are girls of approximately twenty-three years of age who have been on the work for several years.

The aim of motion study investigation therefore is to examine the job from the point of view of the individual who is doing it, and to consider his movements on the job. To do this it is essential to get a complete picture of the operation, to apply the knowledge of movements in respect of the tools and materials which are used, and to consider whether it is possible to supplement and increase the scope of the operator's abilities by the use of additional tools and machines. The need is to have some means of measuring the operation from the above point of view, and to decide to what extent such methods are justified. The methods of measuring devised, developed, and used by Lilian M. and Frank G. Gilbreth in America are employed. They are three in number:—

(1) Process charting, giving the picture of a job as a whole.

(2) Micromotion photography, measuring the nature and type of the movements.

(3) Chronocyclegraph study, from which it is possible to analyse the path of the movement.

By process charting the process is shown up in an entirely new light and every deviation from the standard practice becomes obvious, and stages come to light which are not at all apparent in the work itself or in a written description of it. In micromotion photography, the operator's actual movements are the centre of attention. Motion pictures are taken of the operation under investigation with a clock in the field of view. Once the film has been exposed and processed, it is projected and analysed, and one of the first things is to show it to the actual operator involved, and any others who particularly wish to see it. A special point has been made of this, as it is felt that it increases the understanding and co-operation. The picture is analysed in every detail, and once an improved method has been completed, as a result of this analysis, an operator has to be trained to do the job, and another to act as substitute. There is now a special training section where each operation is brought for investigation and where the operators are taught. The operator is brought into the section and assured at the beginning that she will get a flat rate of the same average amount that she had been making on piecework for the last ten weeks. This means that from the outset she is not worried with the thought of losing money when stopped or corrected. Then the investigator demonstrates the movements, and allows the operator to start while he watches her very carefully and corrects all wrong movements.

The results of such investigations naturally vary, but the average increase in the daily production per operator of all investigations carried out in the three years the section has been in existence is over 100 per cent. This does not mean the speeding up or driving of the operators, but is due to simplification and elimination of all unnecessary movements. Such results might suggest that the work would become more monotonous, but experience has shown that the reverse is true; operators take more interest in the work than before. One fact proving this is the increase in the number of profitable suggestions made by the operators who have been motion-study trained.

Salesmanship and Prices.

Dr. E. F. Armstrong, speaking in a discussion in Section F (Department of Industrial Co-operation) on Thursday, September 7th, dealing with "Organisation as a Technical Problem," mentioned that a meeting of the Sixth International Congress for Scientific Management, will be held in London in the week beginning July 15th, 1935, under the Presidency of Sir George Beharrell, and that His Royal Highness the Prince of Wales had kindly consented to act as Honorary President of the Congress. Among the general questions to be discussed are (1) the position of scientific management in small or medium-sized works with particular reference to the part associations can play in its promotion; (2) budgetary control of production forecasting; (3) questions affecting distribution, in manufacturing, wholesaling, and retailing; (4) training, with particular reference to the supply of men for the larger commercial undertakings and public administration, and (5) agriculture, the part standardisation of plant products, &c., can play in agricultural economics.

Continuing, Dr. Armstrong expressed the opinion that there was an opportunity for the application of scientific method to salesmanship. In the works during the last decade or more, science had effected many changes for the better, and it would be true to say of not a few industries that their technical efficiency was near a maximum and that it would not be very much increased in the near future, or, at any rate, that those industries had more pressing problems to solve in other directions. There were, of course, some other industries in which there was still great scope for technical progress, and new industries would constantly arise for development. In the main, however, it was on the selling side that there was most to be done. Modern salesmanship had, to some extent, been satisfied by graphs showing an increasing volume of sales accompanied by an increase of overhead costs, though the burden of these per unit sale had been diminished. The corresponding profit and loss curve, however, had often been lost sight of by the salesman; it should be shown on the same graph, for it was the final arbiter of success.

Competition had become so very keen in domestic markets, and still more so in export markets, that the salesman and those at the head of affairs had found it necessary continually to lower prices in order to effect any sales so as to keep the works going. The repercussion of that had been felt by every competitor and its effect was cumulative. It might at least be suggested that in the long run the orders were divided among the chief competitors, and that the same division might have been effected at considerably higher and, therefore, more remunerative prices, had common sense prevailed at the outset and the competitors found it possible to come to some agreement on a quota basis. The attempt seemed to be well worth making; that the task was a difficult one it would be futile to deny, but it was so necessary that industry should be carried on at a profit, and that the limited work available should be shared, that no selfish consideration should be allowed to dominate what had now become world problems. All salesmen and most buyers would welcome controlled prices. The actual price often did not matter so much to a buyer as the fact that a competitor might buy at a lower price.

It was bad policy for the industrial nations to undersell one another to an extent which amounted to a subsidy of the smaller nations which thereby might be placed in a position that they, in turn, were able to engage in manufacture and enter into the whirl of competition and so depress prices still further. He believed there was definite scope for the treatment by scientific methods of these problems.

There was a very full programme in Section G (Engineering) on Friday, September 8th, the greater part being devoted to a general discussion on "The Film in Engineering." Before that was taken, however, Mr. S. Capon read a paper on "The Reduction of Aircraft Noise." Last year, before Section G, Dr. Kaye gave an account of the steps that were being taken to reduce aircraft noise, and in the present paper the author, who is connected with the Royal Aircraft Establishment and has been carrying out researches at the National Physical Laboratory, described the further experimental work in progress at the N.P.L., the Royal Aircraft Establishment, and the Air Defence Experimental Establishment directed to this end. Attention was focussed primarily on the reduction of the noise heard by the occupants of the aircraft. This carries with it some diminution of the noise heard on the ground, although the improvement has not necessarily been the same.

NOISE IN AIRCRAFT.

A marked improvement has already been obtained in our air liners mainly by sound-proofing the cabin walls, and it is claimed that the noise in the cabin which originally compared unfavourably with that of a pneumatic drill at close quarters has, in some instances, been reduced to about that in a train with open windows. Nevertheless, the author does not think the position can be accepted as satisfactory until a marked reduction in the noise emitted by the two chief sources, the air-screw and the engine, has been obtained. At the same time, it is recognised that while the engine and the air-screw are the chief sources of noise, there are others which may require consideration later on, but which are masked at present by louder noises.

So far as the airscrew is concerned, it has been shown that the noise depends primarily on the speed of the tips of the blades, and that lower tip speeds are required for quietness. The improvement obtainable in this way, however, is limited by the engine exhaust noise, which is about 80 decibels in cruising flight. Effective exhaust silencers of the baffle type can be made, but they may involve some increase of fire risk in the event of accident. It is estimated that the noise level in a single-engined aircraft might be reduced to rather less than 70 decibels—approximately that in a train with open windows—by the use of an exhaust silencer and low-speed airscrew, say, 650ft. per second. An airscrew tip speed of 600ft. per second would give an estimated general noise level of 66 decibels if none of the secondary sources of noise—engine clatter, noise due to the vibration of structures, or to air flow over wires, &c.—emerged. The improvement in quietness at the ground due to reduction of tip speed and the use of exhaust silencers, however, awaits investigation.

The paper attempts to link together and interpret the experimental results which have been obtained up to the present, but it is admitted that some of the conclusions are based on experimental evidence which is not strong. In particular, further investigation of the discrepancy between the observations of airscrew noise at zero forward speed and in flight is regarded as being required as well as measurements of exhaust noise under cruising conditions. It is even contemplated that some of the conclusions already drawn will be modified by further experiments. The paper describes in considerable detail measurements made with the Siemens Barkhausen audiometer of aircraft noises in flight and of the noise of airscrews and engines on the ground, various deductions being made as to the means by which the noise may be reduced.

The President (Mr. R. W. Allen) said it was a satisfaction to know that such researches as those described in the paper were being carried on, because they would certainly tend to make life more bearable. Somewhat grimly remarking that the real solution of the noise problem from the point of view of the human being was death, he recalled that in the Navy similar troubles had been experienced, and quoted an instance in which the noise from a destroyer was heard 10 miles away.

Mr. H. E. Wimperis, after expressing his appreciation of the wonderful researches that are being carried out in this connection by Mr. Capon, under the guidance of the Royal Aircraft Establishment, and by Dr. Tucker for the War Office, said the most remarkable result achieved so far in aircraft was the passing of the cotton-wool era in civil aviation, for it was only a short while ago that all passengers had to use cotton wool in their ears to lessen the effect of the noise. On the new Handley Page machines, however, that was no longer necessary. Moreover, the enormous and continued growth of the traffic carried by Imperial Airways was due in a very large measure to the success of the work of Mr. Capon and Dr. Tucker. An important application of this work also was in rendering the cabins of the wireless operators on Army aeroplanes and naval seaplanes less noisy, a serious problem hitherto. Speaking of the emphatic desire of the public that aircraft noises should be reduced, Mr. Wimperis said it was amazing that, whilst that opinion was generally held, the public continued to tolerate, without protest, the awful noises from pneumatic drills, motor horns, &c., which were such a common feature of every-day life on the ground. Personally, he did not see why the relatively harmless noise from aeroplanes should be singled out for attack by the public. If the public protested, in regard to pneumatic drills, &c., as vehemently as it had done with regard to aircraft, that it wanted something done, perhaps there would be an abatement of those nuisances. Whilst steps were being taken to deal with aircraft noises, nothing was being done in the other directions to which he had alluded.

Dr. W. S. Tucker said that whilst the Barkhausen instrument had done wonderful work, we really still had no more accurate method of measuring noise than the human ear. With the Barkhausen instrument it was possible to have an error of as much as 6 decibels, which meant that one could not distinguish between one noise and another which was four times as loud. In cases where measurements had been taken as close as 10ft. or 12ft. from the ground, the noise was so great as to be positively painful to the ear, whilst in the air the effect of extraneous noises due to engine clatter, &c., was such that the human ear was quite incapable of giving logical results, even when the sound was reduced by 10, 15, or 20 decibels. Another difficulty when measuring noise from aircraft in flight was that the sound was directed by the motion of the machine, so that the noise was greater when measured in one direction than when measured in another. For that reason it was very difficult to assess whether the silencing of an aeroplane had been successful or not.

Dr. Miller, speaking on the medical aspect of noise, expressed the view that the noise from aircraft in flight was not so injurious to human beings as other noises on the ground which were intermittent. The continual noise from aircraft soon ceased to stimulate; indeed, many people regarded it as a musical note which was not in any sense objectionable. In addition to the other noises on the ground mentioned by Mr. Wimperis, there were the fearful and sudden snorts from locomotives at railway termini, and also the sudden piercing blasts on the whistles of locomotives, both of which seemed to him quite unnecessary and far more objectionable and injurious than any noise from aircraft.

Sir Henry Fowler asked what had happened in regard to the resolution passed by Section G at last year's meeting, calling upon the Home Office to take steps with regard to noise on the ground, more particularly with regard to motor bicycles.

Mr. J. S. Wilson (Recorder, Section G), said the resolution was sent forward by the General Committee to the Ministry of Transport and the Board of Trade, and was formally acknowledged, but so far as he was aware nothing had been done. It might therefore be useful to endorse that resolution on the present occasion and again put it before the General Committee.

Speaking on the paper, Mr. Wilson said it was a serious matter to be told that the only real method of measuring noise at the present time was the human ear, because if it were desired to fine people for making undue noise, there must be some scientifically accurate method of measuring it. It was therefore to be hoped that a method would soon be devised.

Wing Commander T. R. Cave-Brown-Cave suggested the importance of calling attention to the manner in which the principles arrived at as the result of those experiments could be applied to general problems. In the case of the motor bicycle, he believed it was absolutely true that a resonable form of silencer could be fitted, which would reduce the noise to a quite inoffensive one, but at the same time would not reduce the power to an extent that could be noticed by any driver. It would have been interesting if the author had indicated the extent to which the power of aircraft engines was reduced by the fitting of silencers or the reduction of airscrew tip speeds. Incidentally, he recalled some German experiments in which the adoption of slow rotating airscrews revealed the noise from the gear to be the dominant one. How would the large geared airscrew suggested by the author affect that aspect? On one occasion when at Farnborough he had suggested using an exhaust pipe perforated over a considerable length, and a considerable degree of silence was produced in that way. Could the author say whether that would give a reduction comparable with the 37 decibels now considered the optimum.

Dr. S. J. Davies (Joint Secretary, Section G), said that the Sunbeam Company had shown that it was possible to produce a silent-running motor cycle without seriously impairing the power. Speaking on the aerodynamic side, he asked for information as to the relation of the variation of the Reynolds number to the production and transmission of noise from the tips of the propeller blades. He also asked whether any allowance had been made in the tests of engines on the test bed for reflected noise in the engine-house, as compared with the conditions in the air.

Mr. Capon, replying to the discussion, said he believed that with an airscrew tip speed of 650ft. per second, a good take-off would be obtained, and the power in the air would not be less. There would be a considerable reduction of noise in that event. As to Dr. Davies' remarks on the conditions in the test house, allowance had been made for them in the results given in the paper, although it was not easy to make.

Dr. Davies, at the request of the President, read the text of the resolution concerning noise passed last year, as follows:—

> "That the British Association calls the attention of the Home Office to the objectionable and largely preventible noises caused by motor vehicles, and suggests that the Home Office should make greater use of the powers that they possess for dealing with such nuisances."

Sir Henry Fowler suggested it should be added that, so far as motor bicycles are concerned, a diminution in noise does not mean any practical diminution in power.

Wing-Commander Cave-Brown-Cave thought it would be narrowing the basis of the resolution by mentioning one example and suggested that attention should be drawn to the fact that in regard to aircraft certain principles for the reduction of noise had been evolved, and if those general principles could be laid down in a form in which they would be applicable to general problems, much more effective action could be taken by the Association.

Eventually it was agreed to refer the matter to the Committee of the Section, which was asked to draw up a suitable resolution.

THE FILM IN ENGINEERING.

The Section then discussed the question of "The Film in Engineering." This was opened by Mr. H. E. Wimperis, of the Air Ministry, who showed films indicating the manner in which films are being applied to aeronautical research. He pointed out that the film may be used in three quite different ways in engineering research. The simplest use was to record the rapidly changing indications on the dials of instruments in cases where it was impossible to have an observer, or where, if there was one, he could not make and record his observations quickly enough. An example was the "automatic observer," used in the testing of single-seater aircraft. Another use lay in the ability of the cinema camera to make, at any desired speed, a record of the position or altitude of some moving body, the films being afterwards measured up under a microscope. An example was found in the study of the motion of the spin of a free flying model, whilst another was the study of the full-scale motion of porpoising in a flying boat. The third method of using the film was to take slow-motion pictures of rapid movements so that they could be easily followed by the eye, thus enabling the quality of the action to be studied or demonstrated, *e.g.*, the study of the launching of an airplane from a catapult.

A number of films illustrating these uses of the cinema camera were shown. Among the points indicated by these films was the precise action of the Handley Page slot in preventing stalling; the manner in which the undercarriage takes the shock of landing, and the manner in which new landing devices have been evolved to meet the higher landing speeds which tend to follow higher flying speeds, such as the Oleo dashpot arrangement, and so on. It was explained that no new type of Army aeroplane is allowed to be put into construction until it has passed through, in the model stage, a series of tests, all of which were indicated on the film.

Sir Henry Fowler followed with a film and a brief description of the oversea motor unit designed for transport in the Dominions and Colonies where road conditions outside the town are not of the best, which was fully described and illustrated in our issue of July 21st, 1933.

"The Testing of Electrical Switch Equipment" was the subject of the next film, which was exhibited by Mr. W. Wilson. Mr. Wilson expressed the view that the cinema camera and similar recording cameras were of the greatest use in connection with the testing of electrical equipment and were destined to play an increasingly important part in such work.

Their principal uses were said to be, first, the recording of the visual results of tests, more especially those effects which might be too transient for reliable detection by the eye, and secondly, the keeping of a continuous and simultaneous record of the readings of a comparatively large number of meters during a long cycle test. Tests belonging to the first category were exemplified as those on electrical circuit-breaking apparatus, such as large oil-immersed breakers, high-speed air circuit breakers, fusible cut-outs, and lightning arresters. In all these, the significant part of the test lasted only a short time, such as from one cycle to seven cycles (20 milli-seconds to 140 milli-seconds), and a complete record could, therefore, be afforded by only a few feet of film. The data supplied by the photographic record included the nature and duration of the arc—in the case of an air-break apparatus—the emission of flame, smoke, or molten metal, the duration and speed of any visible effects and, not least important, the moving or springing of the various parts. Such records were especially valuable in that they were not only able to detect such occurrences, but also to measure with a close degree of accuracy their dimensions and duration.

Illustrations of such records were exhibited. One example was from a film recording a dead short circuit to earth at a grid sub-station, and was actually taken out of doors while the blizzard of February 24th last was at its height. The arc was struck between a pair of horns by bridging them with a fuse wire prior to the closing of the main breaker. Besides showing the successive shapes assumed by the arc while it was extending, the film also indicated the relative intensity at the various stages, and its duration. The total length of the arc in that case was from 14ft. to 20ft., and extinction was brought about by the opening of the circuit breaker.

Since the duration was short, and the luminosity was intense, most arcing tests could be very conveniently recorded by means of a simplified form of motion-picture camera, which rendered high speeds practicable, and required only a single glass plate of, say, half-plate or whole-plate size. Such a camera had, the author said, been designed in the laboratory of the firm with which he was associated, and consisted of twelve similar lenses, each of which produced a separate image and was uncapped in turn by means of a simple rotary disc shutter driven by an electric motor. Field and armature regulation of the latter varied the speed of the shutter over a wide range. For instance, twenty-four to one hundred pictures might be taken per second, the speed being capable of exact measurement. Examples of the records thus obtained were illustrated. Tests with that camera showed that the extinction of a direct current arc was complete in one-third of a second, whilst an alternating-current arc took only one-sixteenth of a second. Attention was called to an interesting feature in connection with the rupture of an arc arising out of these tests. The common theory was that it snaps at one point, very much like a stretched thread, and quite wrong conclusions have been based on that assumption. The photographs proved that this was not the case, but that the arc persisted until there was not sufficient electrical input to maintain its temperature and consequent ionisation, whereupon it faded away uniformly over its whole length.

One of the great advantages of photographic recording, said Mr. Wilson, was its ability to give a comprehensive and definitely correlated account of the behaviour of all the pieces of apparatus concerned in a test, enabling cause and effect to be seen together. An instance was illustrated where the protection of rotary converters by a high-speed circuit breaker was analysed. In order to obviate the highly destructive effects resulting from the flashovers to which traction machines are subject, the air circuit breaker must be able to open its contacts and break the circuit in 0·1 second or less. After both rotaries had been short-circuited, and were beginning to flashover, the film showed that the high-speed breaker had already begun to function. Before 0·38 second had elapsed the flashover was extinguished, and the circuit broken. The concluding portion of the film explained a curious apparent prolongation of that particular arc at the commutator of one of the machines, a phenomenon now seen to be due to a transient recrudescence of the flashover through a species of alternating-current surge taking place while the circuit was actually broken.

Finally, an example of the second type of test film mentioned was shown, viz., the simultaneous recording by the cinema of numerous quantities during a test cycle. It related to an assembly of no less than seventeen instruments employed during the sea trials of the 19,000-ton electrically propelled quadruple-screw liner "Queen of Bermuda." The ship was put through a specified series of manœuvres, including starting, varying speed, and sudden reversal, and the various meters indicated the time, helm position, reading of the ship's log, voltage, excitation, and speed of each of the two alternators, and the armature current and speed of each of the four motors driving the propellers. A study of the successive readings was found to be of the greatest value in determining the transient effects at the various points of the cycle.

To conclude this discussion and exhibition of film, Mr. Alec Rodger, of the National Institute of Industrial Psychology, showed a film illustrative of some of the applications of the cinematograph film to that side of engineering which deals with the selection of operatives.

The President, in bringing the meeting to a close, and thanking all who had taken part in the proceedings, suggested that any doubts that might have existed as to the value of the use of the cinematograph film for engineering and industrial purposes generally must have been removed by what had been seen that morning. He recalled that when in 1929 he went to Tokyo as a British delegate to the World Power Congress, he thought it might stimulate manufacturers here if he took a film depicting certain directions in which trade might be developed and extended in Japan, and added that that film had been in great demand in this country on many occasions since. Another example was the film which had been taken by Sir Henry Fowler of all the stages of the building of his wonderful "Royal Scot" locomotive when he was at Derby.

(To be continued.)

Obituary.

SIR GILBERT VYLE.

SIR GILBERT VYLE, whose death, after a long illness, will be deeply deplored, was an engineer who, by force of circumstances or taste, had given up the technological side of his vocation and devoted himself principally to economic questions. We have two or three living examples of such men, and it is difficult to over-rate their value. Being able to speak to engineers as one of themselves, and being also in close touch with engineering industries, their words are listened to with a degree of attention greater than that usually accorded to abstract economists, and their advice is sought and respected. A mere list of Sir Gilbert Vyle's engagements shows the nature of his interests. He was a member of the Royal Commission on Decimal Coinage, of the Water Power Resources Committee, of the Safeguarding Inquiry Panel, of the Special Inquiry into Fabric Gloves, of the Departmental Inquiry into the British Industries Fair, of Lord Chelmsford's Committee on the British Industries Fair, and of the Inquiry into the Exports Credit System. At Geneva he was the Government adviser on imports and exports restrictions, and was trade adviser to the British Government Delegation at the Ottawa Conference. In 1923 he was President of the Birmingham Chamber of Commerce; in 1926–1927 President of the Association of British Chambers of Commerce; and in 1929–1930 President of the British Engineers' Association. He was also at one time Vice-president of the Engineering and National Employers' Federation, and Chairman of the British Committee on Empire Trade; and he had been a member of the Development Council, Department of Overseas Trade, and of the executive Committee of the Travel Association of Great Britain and Ireland.

The Engineer

SIR GILBERT VYLE

In all his undertakings, as adumbrated by the list we have just given, he shone as an imperialist. In him there was no "craven fear of being great." He believed stoutly in the British Empire and desired to see it knit ever more closely together. In his speeches—he was an exceptionally clear and effective speaker—he often urged the need of permanent machinery for regular consultations between the various parts of the Empire. "We require," he said, in a speech which may be regarded as typical, "a permanent establishment, a Ministry, if you like, of all the Ministries of the Empire, devoted solely to the work of developing the trade of the Empire. It must have powers to investigate and to advise as to the policies which will give us what is needed in order to develop inter-Imperial trade." Having great knowledge of the needs of industry at home and in the Dominions, he was able to enforce his opinions by sound and effective argument.

Sir Gilbert was only sixty-three at the time of his death on September 7th. He was the son of Mr. Samuel Vyle, of Haverfordwest, in Pembrokeshire, who was one of the pioneers of electricity supply, and it was natural that he should have been trained as an electrical engineer. As a young man he entered the engineering branch of the Post Office, but a few years later went abroad in the service of the Colonial Office. On his return he took up the manufacture of electrical apparatus, but surrendered it when he had developed a practice as a consulting industrial engineer in Manchester. Subsequently, he joined the Board of W. and T. Avery, Ltd., of Birmingham, and became managing director. During the war he was engaged on the organisation of aircraft supply, and the production of other war material, and he was Chairman of the Finance Sub-Committee of the Ministry of Munitions.

In recognition of his many public services, he was knighted in 1928, and was this year created a K.B.E. He will be missed particularly by the members of the British Engineers' Association, for his was a very familiar figure at the Association luncheons, and his attitude towards the engineering industries was exactly suited to the inclination and interests of the members.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"MONEY v. MAN."

SIR,—May I congratulate you on your leading article drawing attention to the Presidential Address of Sir Frederick Gowland Hopkins to the British Association on September 6th, and more particularly for singling out his remarks on the present dangers of "Money *versus* Man"?

That this is a pressing danger to-day may be seen in the fact of starvation in the midst of plenty to which you allude, a situation which obviously arises from the inability of those who are starving to secure the money necessary to enable them to satisfy their needs.

The operators of the money system have arrogated to themselves for too long the position of dictators of morals by maintaining their doctrine of scarcity and the Pauline injunction of "work or starve" in an age of actual and much greater potential plenty. This injunction was justifiable at the time of its pronouncement, and doubtless for many years afterwards, but its enforcement to-day is a crime, the heinousness of which is indicated by the ever-rising number of suicides in every industrialised country, including our own.

To-day, labour—*i.e.*, work for mere sustenance—becomes decreasingly necessary as a result of the application of solar energy to the problems of production; but while work remains man's only claim to a share in the abundance thus created, the discoveries and inventions of the scientist and engineer must be a curse instead of a blessing.

Because, both in this country and the United States, this question is being approached as a problem of providing work instead of one of distribution, and man's claim to a share of the benefits accruing from the labours of the past—a truly communal cultural inheritance—is ignored, no trade revival in either country can be permanent, and the greater such a revival appears, the greater must be the subsequent slump.

All technicians should take warning from the recent acts of sabotage resulting from financial dictation, the destruction of unsaleable, though not unwanted surpluses, and so-called redundant plant, for, if they do not unite for resistance, they may yet find such activities as the discovery and invention of improved productive processes indicted as criminal offences against the community.

M. JACKLIN.

West Clandon, Surrey, September 12th.

AGRICULTURAL MACHINERY TESTING COMMITTEE.—A revised edition of the explanatory pamphlet describing the scheme of the Ministry of Agriculture and Fisheries for the testing of agricultural machinery and implements has just been issued. Certain changes have recently been made in this scheme with the object of making it of more service to the interests concerned. As in the past, a certificate and report on each test will be issued. The certificate will be in a more concise form than formerly; it will state the bare facts of the test, and will be suitable for reprinting in a catalogue or other literature. The report, in addition to giving the details of the test and the results obtained, may contain expressions of opinion with regard to the design and performance of the machine. Both certificate and report will be published by the Ministry in one pamphlet, and either or both may be reprinted by the applicant for his own use. Copies of the pamphlet may be obtained free of charge from the Secretary, Ministry of Agriculture and Fisheries, 10, Whitehall-place, London, S.W.1.

Railway and Road Matters.

At Leicester siding accommodation, which will permit wagons containing an additional 180 tons of traffic to be dealt with at one time, is to be laid down in the L.M.S. goods shed, together with improved cranage and traverser facilities.

A new "halt," known as Gelli Felen, situated between Brynmawr and Clydach stations on the L.M.S. Railway's Abergavenny-Merthyr line, was opened for traffic on September 6th. It will provide railway facilities for several villages in the Llanelly Hill district.

Four wagons, left standing on the up main line at Bowling on the Glasgow and Helensburgh section of the London and North-Eastern Railway, were, on the morning of Friday, September 8th, run into by an express at high speed. There were, however, no cases of personal injury.

The present President of the Trades Union Congress, Mr. A. G. Walkden, is a former railway servant. He was a clerk on the Great Northern Railway, but left railway service in 1900 to become the general secretary of the Railway Clerks' Association, for which and for the railway companies he has done good work in a quiet, unostentatious way.

The new docks and marine manager, Southern Railway, in place of Mr. G. R. Wencombe, who has retired owing to ill-health, is Mr. E. J. Missenden, who has been the assistant superintendent of operation in the traffic department. Mr. R. P. Biddle, who was the assistant marine manager, has been given the rank of assistant docks and marine manager.

We are informed by Sir W. G. Armstrong Whitworth and Co. (Engineers), Ltd., that reports have recently appeared in the Press to the effect that their new 800 H.P. Diesel-electric locomotive is capable of hauling a load of only 250 passengers. This, they say, is a considerable understatement of its capabilities, since the locomotive can haul from six to eight ordinary passenger coaches.

As is generally known, the railway companies, mainly because some leaders of the men announced beforehand that they would not accept the award of the National Wages Board last December on a question then still under consideration, gave twelve months' notice in January of their withdrawal from the Central and National Wages Boards. They, at the same time, intimated that they would be prepared to consider the adoption of some more suitable procedure. It is now announced that the companies have approached the three railway unions as to a meeting shortly to discuss the question.

So much attention has been paid to the valuable national services rendered by the late Viscount Grey, that the fact may escape notice that he was closely identified with the North-Eastern Railway and its successor, the London and North-Eastern. He joined the board of the former company in 1899 and became its chairman in 1904, but resigned his directorship when he joined the Campbell-Bannerman Government in December, 1905. His retirement from the position of Secretary of State for Foreign Affairs, after holding that office continuously for eleven years, permitted his return in 1917 to the North-Eastern Board, and he remained a director when the L. and N.E. was formed.

The fusion of the Metropolitan Railway, along with the Metropolitan District and the tube railways, into the London Passenger Transport Board, is, it is announced, about to lead to the removal of an inconvenience experienced by passengers journeying between the District line and the Uxbridge branch of the Metropolitan. The latter, besides being between Harrow and Uxbridge, has a branch from Rayners-lane, which was opened on March 1st, 1910, and makes an end-on connection with the District Railway at South Harrow. The inconvenience mentioned above is that passengers have to change trains, and generally platforms also. That is shortly to be removed by through District and tube trains to and from Uxbridge.

The Bishops-road Station of what, for convenience, we will refer to as the Metropolitan Railway ceased to exist as a separate entity on Monday last, September 11th, having been merged into the Paddington Station of the Great Western. The City Railway Company was formed in 1852, and in the following year the North Metropolitan Railway was sanctioned, which name was changed to the Metropolitan Railway Company in 1854. Under the Act of the latter year, the railway was to start opposite the Great Western Hotel, *i.e.*, in Praed-street, and there was to be a junction with the Great Western at Bishops-road. The line was opened on January 10th, 1863, and was worked with Great Western engines and coaches, for which purpose the railway was of mixed gauge, as the Great Western rolling stock was of the broad gauge. The Great Western still exercises its running powers for goods traffic, but the steam locomotives of the passenger trains are exchanged for electric at Bishops-road.

Although it was only as recently as May 19th last that we gave the assurance that no train accidents can result from a signalman dying or being taken ill at his post, we must again refer to that subject because of the remarks made on August 31st by the Manchester County coroner at the inquest on a signalman who, after having been found in a state of collapse in his signal-box, died in Manchester Infirmary. The coroner is reported to have said that should sudden death overtake an engine-driver it was possible that his fireman might avert a catastrophe, but if a signalman died while working alone in his cabin the consequences might be too awful to contemplate. That, we would repeat, is not so. No train is allowed to approach a signal-box without the permission of the signalman there. If that man is incapacitated he cannot give the permission, and his silence would lead to inquiry; if he was taken ill after permission had been given his failure to report the passage of the train would raise suspicion. In this particular case the man's signals were against a train, and its prolonged detention led to the fireman going to the box and finding the signalman ill. Further, all the time the train was detained no second train could follow it.

Notes and Memoranda.

For brass, drills are best made with straight instead of spiral flutes. A twist drill in brass is "greedy," while in deep holes the chips come off in such a way that they fuse into a solid mass in the flutes, and are difficult to get away.

It is, says the *Machine Tool Review*, considered standard practice to-day to finish automobile and aeroplane motor cylinder bores by honing with abrasive sticks. Automobile cylinders, for example, reamed to within 0·002in. or 0·003in. of size, are honed to an accuracy of 0·0005in. at the rate of 95 six or eight-cylinder blocks per hour on a multiple-spindle honing machine under the supervision of one operator and a helper.

Scientific circles in Cracow, states the *Chemical Trade Journal*, are keenly interested in a remarkable phenomenon which has occurred at Krynitsa, a Polish health resort close to the Czecho Slovak frontier. While work was proceeding on a new mineral water boring solidified carbon dioxide was brought to the surface from a depth of 2800ft., settled on the ground like a light covering of snow, and then quickly evaporated. It is claimed that this is the first time solidified carbon dioxide has appeared directly in nature. The solidification is ascribed to the terrific pressure which must exist in the subterranean regions from which the gas escaped.

The oil and mineral riches of Chinese Turkestan are described in the *English Review* by P. S. Nazdroff. The oil is worked to the west of Kashgar at a place called Kusheiku, near the city of Ak Su, and at Kucha. It is simply distilled for lamp oil and burns excellently in the native chiraks without any purification. Like the oil of Russian Turkestan, it has a high content of paraffin wax. At Kashgar, near Ming Yul, the oil contains a considerable proportion of benzine. At Kucha it is of a light yellow colour, precipitating on freezing an almost pure white paraffin wax. There can be no doubt that these deposits of oil will one day play a very important part in the life of Siberia and the Far East.

Of the seventy-five elevators in the new Rockefeller Centre Building in New York, twenty-four normally rated 3500 lb. at 1200 f.p.m. are, says the *Engineering News-Record*, of particular interest, as they are the highest speed passenger elevators in operation. Some of them have been operated at 1500 f.p.m., during performance tests, and one has been approved by the city inspectors to operate at 1400 f.p.m. These elevators are of the automatic landing type; they travel from 497ft. to 779ft., and some of them represent a total suspended load of about 25,530 lb. The highest-rise cars make a round trip with terminal stops only in 95 seconds. They will be in motion about 58 per cent. of the time, and for 40 per cent. of the time will be running at full speed. These duties and the long express runs involved require an elevator machine motor with a rating of 100 H.P.

Wawona Tunnel in America is 4233ft. long, absolutely straight, and is cut through solid granite the entire distance. It was constructed to make possible a road with a maximum gradient of 5 per cent. from Fresno and Los Angeles to the Yosemite Valley floor by way of the Wawona Big Trees. From the mouth of the tunnel magnificent Yosemite Valley bursts into full view, including such spots of scenic grandeur as snow-capped "Clouds Rest," the massive granite mountain "Half Dome," the sheer 3600ft. precipice of "El Capitan," and beautiful "Bridal Veil Falls." The tunnel proper consists of a 24ft. roadway and a 3ft. walk. To protect visitors from carbon monoxide gas detectors are installed, which automatically operate two 250 lb. General Electric thrustors to close the dampers, and three 150 lb. thrustors to open the fan shutters and start the fans. This operation is reversed when the air becomes purified. The fans are installed in a ventilation tunnel drilled to the face of the cliff from about the centre of the tunnel.

New York City is, says Mr. R. G. Albion, of Princetown University, essentially a product of the Communication Revolution. The Industrial Revolution may have been responsible for the growth of Manchester, Birmingham, and Pittsburgh. New York, on the other hand, first drew ahead of its rivals because of its foresightedness in digging a canal to draw grain from the West, establishing liners to draw manufactures from Europe, and utilising the steamboat to distribute its products along the coast. If new communication devices gave New York its start, they were absolutely necessary to handle its ever-increasing population. In 1800, it had about 72,000 inhabitants; in 1930, the municipal area contained nearly seven million, and the whole metropolitan area about eleven million. Ingenuity was taxed in getting the surplus workers to and from their homes. About a century ago, the omnibus and then the horse car were temporary solutions, soon followed by the steam railway. In 1867, an elevated railway, using steam at first, was built to relieve congestion on the streets. Twenty years or so later, electricity came to the rescue with surface cars, and, later, electric elevated trains.

The incidence of silicosis is discussed in a report just issued by the Mining Research Laboratory of Birmingham University. The presence of silicosis and dust in coal mines, it is stated, is of great importance to the mining industry on account of the increase in compensation claims which it makes liable. About fifty samples of stone dust were obtained during the year from various collieries throughout Great Britain and analysed for free silica. Up to the present samples have been obtained from collieries producing a total of about 40,000,000 tons of coal a year. Continuation of the work is considered to be desirable, since several collieries appear to be using dust containing more than 35 per cent. free silica. Analysis showed that almost invariably the free silica content of the dust suspended in the air is appreciably less than that in the borings. It is hoped to find out whether this difference is due to the harder crystals of free silica being powdered to a lesser extent than the softer material of the rock. It is believed that the retention by the management of a sample representative of all borings during the driving of a stone heading would place the colliery in a much better position to meet future claims.

Miscellanea.

The new Zeppelin being built in Germany, with a capacity of 7,000,000 cubic feet, will probably be finished by the spring of 1934. She will have accommodation for fifty passengers.

The number of wireless receiving licences issued during August was 225,000. After allowing for those which had expired the total number in force at the end of August was 5,654,400, a net increase of 29,500.

The attendance at the British Association meeting at Leicester was about 1200, which is about the average of recent years, excepting special occasions. The meeting next year will be held in Aberdeen, and the President will be Sir William Hardy, F.R.S.

August shipments of iron and steel from the Tees were heavier than in any month this year with the exception of May, notwithstanding the interruption of the annual holiday period, which caused a cessation of deliveries to certain districts. Last month's loadings totalled 39,682 tons, compared with 35,555 tons in July. The August figures included 12,848 tons of pig iron, 2069 tons of manufactured iron, and 24,765 tons of steel.

A hint for our Electricity Commissioners :—The Dewan Saheb of Junagad has issued an order, states the *Times of India* correspondent, that as electric power is now available all holders of licences for working oil engines in flour and oil mills should note that, unless any reason to the contrary exists in individual cases, their licences will not be renewed after October 31st, 1933, as oil engines are open to objection in towns because of their noise and the deleterious effect of the fumes of their exhaust.

For the first time in the history of the British gas industry, now in its 135th year, an official visit is being paid to the Canadian and American gas industry. On Friday last, September 8th, the President, Mr. Frank P. Tarratt, and sixty members of the Institution of Gas Engineers, left to attend the Twenty-sixth Canadian Gas Convention in Ottawa, and the International Gas Conference and Fifteenth American Gas Convention at the Chicago Centennial International Exposition in Chicago.

During the first week of this month a meeting took place at Berlin between the Ruhr steel works and representatives of the Siegerland iron ore mining industry and the scrap trade, in order to arrive at a definite agreement regarding the disposal of ore from the Sieg, Lahn, and Dill districts and of manganese ore from the Geyer mine. The steel works alone have agreed to accept 36,000 tons of Siegerland ore per annum and 24,000 tons from the Lahn and Dill. Scrap imports are also to be restricted to help the iron ore mines.

The two sintering plants being erected respectively by the Appleby Iron Company, Ltd., at Scunthorpe, and by a Leeds firm at Gunness Wharf, also in the neighbourhood of Scunthorpe, are, says the *Iron and Coal Trades Review*, of the Greenawalt system. The plant for the Appleby Iron Company is to have an initial capacity of 800 tons of sinter per day, with an ultimate extension of the plant to double this capacity. The other Greenawalt sintering plant, under erection at Gunness Wharf, will have a capacity of 75 tons of finished sinter per day.

The Official Returns given to the Electricity Commissioners show that 928,000,000 units of electricity were generated by authorised undertakers in Great Britain during last August, as compared with the revised figure of 816,000,000 units in the corresponding month of 1932. This represents an increase of 112,000,000 units, or 13·7 per cent. The number of working days in the month (excluding Sundays and Bank Holidays) was twenty-six, the same as last year. During the first eight months of 1933, up to the end of August, the total amount of electricity generated by authorised undertakers was 8,329,000,000 units as compared with the revised figure of 7,718,000,000 units for the corresponding period of 1932. This is an increase of 611,000,000 units, or 7·9 per cent.

Improved voltage regulation on many of the rural feeders of the Niagara, Lockport, and Ontario Power Company, has been attained by installation of the recently announced General Electric step-voltage regulators for rural service. The first regulator, obtained in April, was installed with a minimum of time and expense because of its compact arrangement and built-in automatic features. Regulation on the Panama section of the feeder, 7 miles from the step regulator, has been improved from approximately 5·5 per cent. to 1·8 per cent.; on the Niobe section, 8 miles from the regulator, from 5·6 to 1·8 per cent.; and on the Blockville section of the feeder, 2½ miles from the regulator, from 3·6 to 1·8 per cent. Subsequent to this initial installation, the power company purchased two additional step-voltage regulators which are now about to be installed. In the lay-out for all new and re-conditioned existing rural sub-stations, the company is providing space for not only an automatic reclosing feeder breaker, but also a step-voltage regulator.

Although the British Industries Fair does not open until February 19th, the Department of Overseas Trade reports that it has already received applications for more than 90 per cent. of the space occupied by exhibitors at Olympia and in the furniture section at the White City at the last Fair. According to *The Times*, up to August 28th applications were received from 875 prospective exhibitors for a total of 341,118 square feet of exhibition space. At the 1933 Fair 1438 exhibitors in the corresponding groups occupied 378,867 square feet. The greatest increase is in the furniture and basketware group, in which applications have been received from 169 prospective exhibitors for 123,987 square feet of exhibition space, against 98,721 square feet occupied by 179 exhibitors at the 1933 Fair. In the "heavy industries" section at Birmingham advance bookings of space by exhibitors are so far ahead of those last year, and, indeed, in any previous year, that some 55,000 square feet of indoor area is being added immediately to meet pressing demands. Special activity is reported in the gas, electricity, building, and engineering groups.

TRANEBERG CONCRETE ARCH BRIDGE AT STOCKHOLM

MAJOR ERNST NILSSON, STOCKHOLM, DESIGNING ENGINEER

(For description see page 261.)

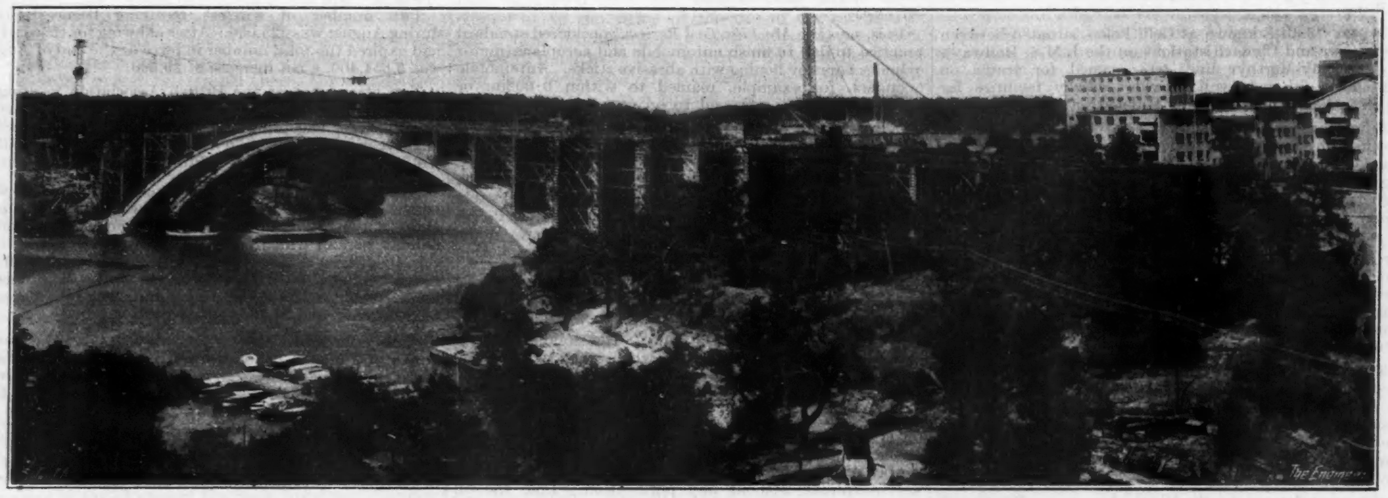


FIG. 1—THE BRIDGE WORKS, JULY, 1933

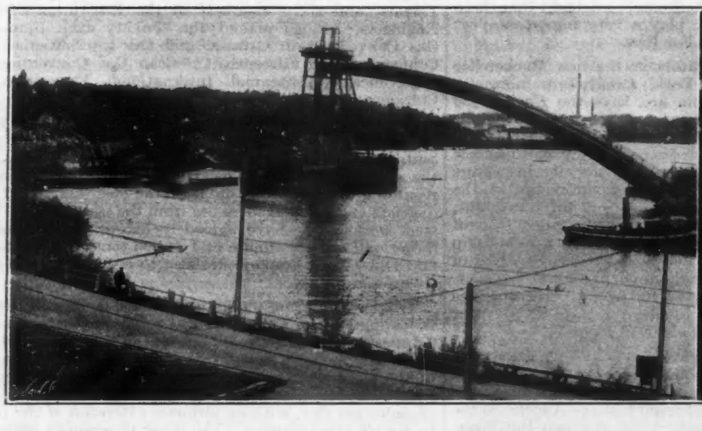


FIG. 2—RAISING TEMPORARY STEEL ARCH

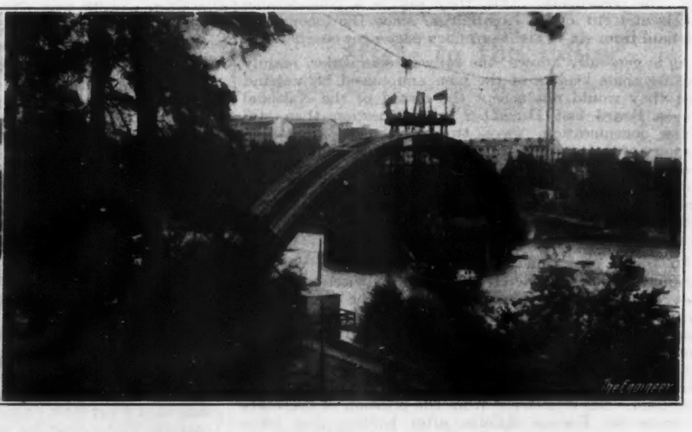


FIG. 3—TEMPORARY STEEL ARCH ON COMPLETION

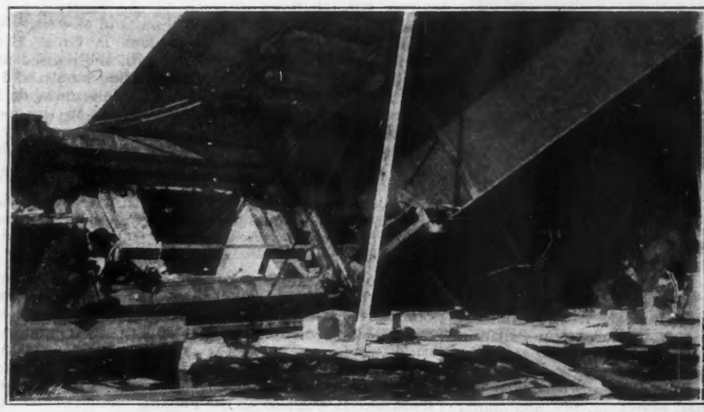


FIG. 4—TRAVERSING STEEL ARCH TO SECOND POSITION

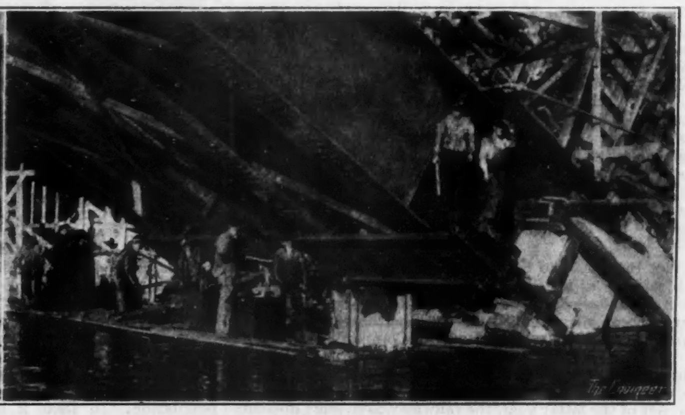


FIG. 5—ADJUSTMENT OF STEEL ARCH BY HYDRAULIC JACKS

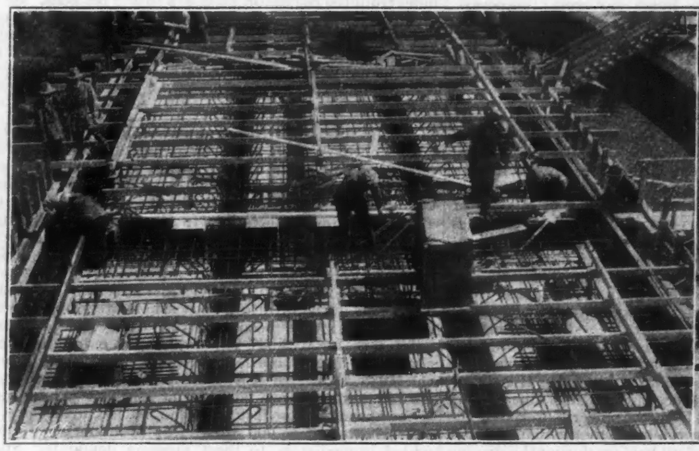


FIG. 6—SHUTTERING FOR CONCRETE ARCH AT CROWN

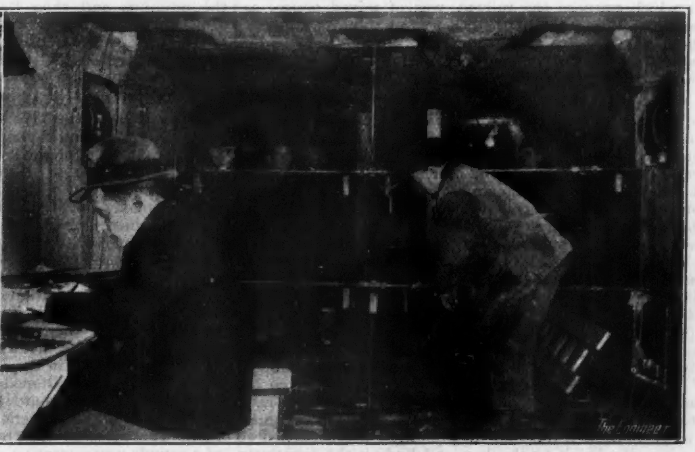


FIG. 7—HYDRAULIC JACKS AT CROWN OF ARCH

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DIVING AND THE YOUNG ENGINEER.

It is a matter of surprise to us that so few professional engineers whose work is connected with under-water construction have acquired the necessary aptitude and experience to enable them to examine such works in helmet diving dress. There are, of course, a few engineers, particularly of the younger generation, who have gained this useful experience, and it is significant that every engineer probationer in the Department of the Civil Engineer-in-Chief of the Admiralty is now required to attain a reasonable proficiency in diving before his appointment as an assistant civil engineer is confirmed. But we submit that the training is not as general as it should be. We have in mind several instances of serious difficulties occurring, and defective construction resulting, in the carrying out of important sea works through neglect of skilled supervision of operations carried out under water. In two of these cases grossly improper work was done by the contractors concerned, or by divers employed by them, but was only possible by reason of the venality of the diving inspectors employed by the engineers. In neither of these cases did the responsible engineer, or the resident engineer, or any qualified member of the staff, examine the work in diving dress. It is expecting too much of human nature to count on every diver carrying out faithfully and completely the work which he is required to do under water in the absence of adequate check and skilled inspection and supervision. We are not suggesting for one moment that contractors' divers or diving inspectors are, as a class, venal or untrustworthy. On the contrary, they are, as a rule, both competent and reliable. But in every class of workers there are occasional black sheep. No engineer would think of leaving to the sole inspection and supervision of a subordinate workman or inspector, without check, any important work of considerable magnitude if carried out in a position accessible to himself; yet in the case of under-water work this is no infrequent occurrence, and neither the engineer nor his responsible deputy sees the work even in its finished state. This is the opportunity for the untrustworthy workman and the black sheep inspector.

It is not necessary that a young civil engineer should become an experienced and effective under-water craftsman. We do not suggest that he should be specially trained, as are diving ratings in the Royal Navy, to perform difficult and arduous tasks in diving dress. All that is essential is that a young man should be able, when it is necessary, to go under water and to examine for himself the condition of the structure or the work done by divers, and to take a few simple measurements. He should also familiarise himself with what is, and what is not, practicable for a working diver to do under water. Many people, including some engineers, regard diving as a difficult and dangerous art, requiring long training and much practice. This view is far from being a true one, at any rate, in its application to the case of the engineer who is qualified to make inspections in a diving dress. A young man, with sound heart and lungs and with reasonable freedom from adipose tissue, should be capable of going under water in ordinary conditions with safety to himself after two or three simple lessons and trial descents. If engineers responsible for harbour and dock works, reservoirs, the sea outfalls of sewage works, and other similar under-water structures, would arrange for suitable facilities to be given to their pupils or assistants in their employment, the necessary training could be carried out on works without interfering to any material extent with constructional operations. If a young man at the end of a professional diver's spell of work is put into the diver's dress and goes down occasionally, under the instruction and supervision of an experienced man, for a short spell, which need not exceed half an hour at a time, the interruption in or delay to the normal work of the diving crew is of small consequence. We know of an engineer who, as a pupil, was placed by his chief in charge of a small sea work in the course of which the employment of a professional diver was necessary for a few weeks. The diver, on the first occasion when his services were required, having completed his spell of work, returned to the diving boat, whereupon the youngster, with more daring than prudence, and lacking the smallest acquaintance with the technique of diving, informed the professional expert that he proposed to put on the dress and to see for himself what had been done, and what would be required for the next day's work. The diver, after expressing some doubt as to the wisdom of that proceeding, at length agreed to clothe his young superior officer in his diving dress. The youth, full of rash confidence and too conceited to confess his complete inexperience, went over the side of the diving boat, but had not descended far before he found himself in difficulties, and shortly afterwards emerged ignominiously and horizontally, and was hauled to the side of the boat like a distended bladder. With some little difficulty he was up-ended and the friendly linesman was able to relieve the situation by opening the air valve in the diver's helmet which the over-confident beginner had not known how to manipulate. A few words of explanation and kindly advice from the older diver set matters right, and another descent was at once begun and carried through with more satisfactory results. That young man during the two or three weeks that diving operations were in progress went down for a short time every day, and thus acquired experience and confidence as a diver which has been of service to him in all his after career. Now, nearly forty years later, he still occasionally puts on a diving dress for the purpose of examining under-water works. There is an important harbour authority whose chief engineer years ago made a practice of inspecting in diving dress once annually the foundations of the breakwaters for which he was responsible, a practice, we believe, that has been continued by his successors ever since. It was known to the whole of the engineering staff and the professional divers in the employment of the port authority that the chief might at any time decide to inspect personally some piece of work in progress under water. This knowledge stimulated the diving staff, and there is no doubt that thereby the efficiency of divers' inspections and of divers' handiwork was increased. It became a matter of professional pride to the staff engaged on the periodical examination of and repairs to the breakwaters, from the resident engineer down to the youngest working diver, to discover and record every defect of importance lest the vigilant eye of the chief, in the course of his annual inspection, should find some weakness of which he had not previously been informed.

Our advice, then, to young engineers engaged on harbour works and other forms of under-water construction, is to seek every reasonable opportunity to gain personal experience of diving operations, and to those responsible for the carrying out of such works to provide facilities for their young subordinates and encourage them to make use of these. There is no question at all that the engineer who has added diving to his accomplishments possesses an asset which counts in his favour when compared with those who have not taken the pains to acquire the necessary skill and experience. It is, perhaps, as well to mention that the would-be diver should, before making his first descent, submit himself to medical inspection in view of the possibility of some undiscovered constitutional weakness which might operate as a bar to working under compressed air.

Electrical Accidents in Mining.

Few engineering matters have claimed more attention during the past twenty years or so than the use of electricity in mines. The design of flameproof enclosures for switchgear, motors, &c., has given rise to much investigation on the part of manufacturers and independent workers anxious to assist electrical progress. As the recently issued 1932 report of H.M. Electrical Inspector of Mines shows, there is now no technical difficulty or serious economic handicap in providing such enclosures for all descriptions of electrical plant in the sizes that are required for the operation of machinery at or in the vicinity of the coal face. This does not apply, however, to such things as large transformers and motors and certain kinds of controlling gear, which must therefore be kept out of the danger zone. Safety in mines is such an important matter that it is essential to ensure that everything associated with electrification is free from defects and that it is capable of passing recognised tests. While the Inspector has no desire to depreciate the tests made on flameproof apparatus at manufacturers' works, he directs attention to the fact that it was agreed with the British Electrical and Allied Manufacturers' Association some ten years ago that type tests to prove immunity from danger should be carried out by an independent authority. During 1932 much work of this nature was done at the Mines Department testing station at Harpur Hill, Buxton, which took over this duty from the Mining Department of the Sheffield University in 1931. Colliery owners are said to be showing a growing tendency to call for plant certified by the recognised authority, for while it is realised that the constructional features necessary to obtain flameproof enclosures are known to some manufacturers, there are others less well informed, and in the absence of independent tests the purchaser has no guarantee that the plant is safe.

How important it is that mining electrical equipment should conform with official requirements is shown by the report on the explosion at the Garswood Hall Colliery, at which twenty-seven lives were lost. Except for this catastrophe the record for electrical accidents for 1932 would have been the most favourable for many years. The cause of the accident, it will be remembered, was attributed to sparking on the signal bell circuit in use at the time. Tests made after the explosion showed that the spark at the trembler contacts, or that at the point where the signal was given, was capable of igniting an inflammable mixture of firedamp and air. This was by far the most serious accident recorded during the year. There were, in fact, only four other fatal accidents attributable to the use of electricity in mines under the Coal Mines Act, 1911, all being simple cases of electric shock. In each case one person was killed. One occurred on the surface and the remaining three below ground. There were in all sixty notifiable non-fatal accidents and dangerous occurrences attributable directly or indirectly to the use of electricity involving injury to sixty-three persons in addition to six persons who were associated with two of the fatal accidents. Forty-four of these accidents were below ground and sixteen on the surface. That there were no ignitions of firedamp other than the one mentioned speaks well for the work of those who have devoted their attention to the design of flameproof enclosures. Accounts are given of all the fatal accidents and of some of the non-fatal and dangerous occurrences. As usual, they show that even experienced men do foolish things and that regulations are not always complied with. In one case an electrician lost his life by relying on a verbal arrangement on the telephone for the supply to be cut off from a joint box instead of properly isolating the circuit himself. While work was in progress the supply was restored, with the result that the man was killed, whilst his assistant received a dangerous shock. Both men seem to have been in the habit of taking extraordinary risks, for at the inquest the surviving electrician explained that it was their practice to test conductors upon which they were about to work by placing a screw driver across them. Although the method has the merit of simplicity, it is obviously liable to lead to very considerable personal injury and in any case gives no safeguard against subsequent restoration of the pressure. Of the non-fatal accidents one was due to the now all too prevalent practice of using circuit breakers of inadequate rupturing capacity. On the occasion of a fault flaming oil was ejected in considerable quantity through the joint between the switch cover and tank. Three men received burns which necessitated the retention of two of them in hospital. Although in this case the Inspector makes no reference to the fact that the rupturing capacity of switchgear is now often made inadequate by the large capacity of generating and transformer plant that is connected to it, many large consumers have found this to be true. As the Electrical Inspector of Factories has recently explained, there is justification for suggesting that in many cases transforming plant might for the present be limited with more consideration to the load demanded, and that the best interests of the authorised undertakers will be served by advising their industrial consumers of the supply conditions that obtain.

But if the report of the Electrical Inspector of Mines indicates the desirability of one change more than another, it surely is in the direction of better supervision and the employment of properly qualified men. Contrary to regulations, men with no electrical knowledge are apparently allowed to carry out work in the vicinity of live conductors without any control over their actions. Cases of this kind may not be numerous, but it is undesirable that they should occur at all. A story is told, for example, of a labourer being left to whitewash the walls in a transformer sub-station whilst the transformer was alive. The assumption apparently was that as he had whitewashed other sub-stations in which there were no exposed live parts, he would be safe under the more dangerous conditions, but unfortunately he was electrocuted. Another case reported points to the obvious fact that when supervisors are provided they should be individuals qualified for the job. A young man, variously described as an electrician's mate, or as a motor man, was told to remain with some bricklayers whilst they performed the work of filling in some holes in a cubicle containing a 2,000-kVA, 10,000/3,000-volt transformer. Not content with the task allotted to him, however, he proceeded to dust the top of the transformer and in doing so received a severe shock and burn. While it would be wrong to assert that for the most part colliery electricians are incompetent, it is clear that they are not always up to the standard that the work demands. Discussing this matter from the point of view of underground maintenance work, in a paper read before four local centres of the I.E.E., Mr. Andrew R. Cooper states that as a general rule men who are capable of the work are not attracted by the conditions, whilst those who are prepared to put up with the disadvantages are of too low a grade to give the service required. Mr. Cooper's recommendations are that certification by some recognised authority of all colliery electricians should become compulsory and that educational authorities should arrange for special electrical courses for young men who desire to specialise in colliery work. Such courses are already available at universities, mining schools, and some technical schools, but there is ample room for more widespread evening instruction to meet the requirements of those who have to combine practical activities with study.

Literature.

Reinforced Concrete Bridge Design. By C. S. Chettoe, B.Sc. (Eng.), M. Inst. C.E., and Haddon C. Adams, M.C., M.A., Assoc. M. Inst. C.E. London: Chapman and Hall, Ltd. 1933. Price 42s.

A book which is indicated by its title as one relating to a particular type of bridge or to bridge design and construction with one kind of material, may reasonably be confined to considerations proper to the employment of the type or material. On the other hand, in such a work the value of this exposition of one part of the art of bridge building may be enhanced, and a sense of the relation of the particular practice to practice generally be conveyed to the reader if it be written in the light of main principles and with the broader aspects of bridge problems present in the mind of its author. Some discussion of problems precedent to the actual designing of the structure, such as those relating to choice of site and choice of type, may considerably add to the value of the book, if so directed as to bear upon the question of the suitability in typical cases of particular forms of the type under consideration, or of the types or forms available with the material named in the title.

In the first respect there can be placed to the credit of the authors of the work under review an excellent chapter on the æsthetics of bridge design, beautifully and instructively illustrated with photographs of bridges; the opening chapter on structural theory; and, facing page 1, a most apt quotation from Ruskin's "The Stones of Venice." Further, the spirit in which the book is written and in which the student should approach the subject is well expressed in the opening paragraph of the preface, in the words: "As both an art and a science, bridge-building is once more coming into its own. It flourished as an art, became a science, and the art was in danger of being forgotten, except by the great bridge-builders in whom science and art were reconciled. To-day, there are signs that the great tradition is to be resumed, and we may with reason hope that 'the best is yet to be'"

As regards problems precedent to actual designing, there is, excepting the matter in the chapters already mentioned and—disappointing in view of a reference in the preface to the subject of choice of type—only about 1½ pages relating to the site and, very briefly to river flow data, the observations being suggestive rather than instructive. There are, of course, a number of passages, in various chapters, which are of some significance with respect to the type of span and the forms suitable under given conditions.

As regards the main exposition, it is sufficient to remark that it has the vigour and clarity to be expected of Mr. Chettoe and Mr. Adams, is well balanced and adequately covers the subject. Major allotments of space are made for treatment of the essentials of reinforced concrete design, of arches, and of substructures. There is a useful chapter on bridge strengthening and widening, and one on vertical curves, horizontal curves and super-elevation. Dealing briefly with the modulus of elasticity of concrete, the authors do not discuss recent researches respecting the variability of the modulus with differences in the nature and proportion of fine aggregate, the water content, the age of the concrete, the disposition of the reinforcement, and other factors. In other respects the significance of the modulus is adequately explained.

This well-written volume of 400 large octavo pages, liberally and usefully illustrated, may be commended as suiting the requirements of both students and bridge engineers.

The Chemistry and Physics of Clays. By Alfred B. Searle. Second edition. London: Ernest Benn, Ltd. Price 55s.

Mr. Searle's work has for long been recognised as one of the most authoritative books on the subject of clays in this or any other language. The revision made in the present second edition has been exceptionally thorough, for we have noticed very few paragraphs which have simply been reproduced from the 1923 edition. This edition also contains several new features. The amount of practical and valuable information that is compressed by Mr. Searle into a comparatively small compass is remarkable, and we have no hesitation in prophesying for this edition an even wider circle of readers than the earlier edition both merited and obtained. No spectacular advance has been recorded in the study of clays during the period covered since the publication of the first edition, but further application has been made of X-ray spectrographic methods and the more general use of physico-chemical technique which are furnishing data of considerable practical importance. The physical and chemical properties of fired kaolins have been investigated by the U.S.A. Bureau of Standards, in which it has been found that the excessive coefficient of expansion of certain fired clays is caused very largely by the presence of cristobalite. Researches of German origin have dealt with the viscosity of clays, together with the influence on viscosity of silicate, carbonate, and caustic alkali ingredients. Italian investigators have studied the action of certain sulphates in flocculating clay suspensions, and also the *rôle* of deflocculents. Some investigations carried out in this country have dealt with the practical applications of deflocculated clay-slip bonds, the effect of various ingredients on the properties of silica bricks, the influence of grading on their porosity, and comparison of the properties of lime and clay-bonded silica bricks prepared from calcined ganister. These and many other investigations are referred to by the author in his volume, which is written in a clear style and with a wide vision.

Commercial Motor Road Transport. By L. M. Meyrick-Jones. London: Sir Isaac Pitman and Sons, Ltd. 1933. Price 15s.

The great expansion of road transport since the war, and the considerable changes in design and in the laws governing transport undertakings, have undoubtedly made it desirable that books on the operation of road transport should be written and published. The book under review can be regarded as up to date in most essentials. Besides an opening chapter dealing with certain general considerations, such as the importance of adequate mileage and the influence of working conditions, the volume is divided into four parts—Mechanical; the Business and Commercial Aspect; Working and Upkeep, and Legal. The latter three parts are likely to be the most useful. In Part II., for instance, working costs for types of vehicles from 5 cwt. to 12 tons are worked out for petrol, heavy oil, steam and electric vehicles. No doubt some operators will challenge the figures or the arrangement of the various items under "running" and "standing" costs. For instance, the author puts the wages of the driver and his assistant under "standing" costs, whereas some operators no doubt would regard this expense as a "running" charge. Worked figures of this nature are bound to be controversial, but they are, nevertheless, a very useful guide. In this section, too, the author has many suggestions to make with regard to the fixing of rates for the carriage of goods and to the recording of the work and other such details. Nor are passenger vehicles neglected, and a chapter is devoted to services and fares. The next section—Part III.—as its title implies, is concerned with upkeep. In these days it is almost a necessity that a work on commercial road transport should have a section devoted to legal questions. In this book the section is kept as short as possible, subject to giving all the needful facts. These three sections make the book a valuable one, but the necessity for including the first—Part I., Mechanical—seems doubtful. It is, in any case, a very elementary sketch of the mechanical construction of road vehicles, and the author might have been better advised to "leave well alone" and refer his readers to books specially devoted to the subject, of which there are many. Sometimes, indeed, the reader is tempted to doubt whether the author's thermodynamical knowledge is sound as, when he states "... as the figure in the assumed example is fairly representative of the petrol engine, which averages 20–25 per cent. [thermal] efficiency, it will be realised that as yet we are able to convert into useful work only a mere fraction of the heat available in the fuel." Again, in explanation of the reason for the lower thermal efficiency of the steam engine, he points out as a source of loss of heat "... a lot is absorbed by the conversion of the water into steam." It is charitable to believe that such remarks as these arise from a desire to put thermodynamical principles into very simple language which may be understood by those with no knowledge of the subject, but, nevertheless, such sentences give rise in the reader's mind to a doubt as to the ability of the author to write as an authority. Apart from Part I., however, the book may be recommended as a useful contribution to a subject not yet as completely covered by literature as it might be.

SHORT NOTICES.

Power Plant Engineering and Design. By Frederick T. Morse. London: Chapman and Hall. Price 30s.—An attempt is made in this volume, which is devoted entirely to American practice, to present a thorough study of electric generating stations, including public service, industrial and other plants. Although the volume is primarily intended for the use of students, the author hopes that it will also prove of value to the practising engineer. Special attention is paid to the study of vapour cycles and heat balances. The early chapters cover the variable load problem, power plant economies, and power plant buildings. Oil engine and hydro-electric plant is then considered, and the remainder of the volume is devoted to steam plant. Steam boilers, prime movers, condensers, feed water and piping systems are naturally covered. Although the limited space of one volume makes it impossible to deal with many of the minor details of power plant equipment and lay-out, the author has succeeded in covering the main things that go to make up a power station. There are many instructive pictures and drawings which serve to familiarise students with modern power plant practice. Problems relating to many branches of the subject are set and answered. The electrical section of the volume covers generators, switchgear, and transformers. Instruments of all kinds are dealt with in a separate chapter, which brings the volume to a close.

Elements of Power Generation. By Arthur M. Greene, jun. New York: John Wiley and Sons, Inc. London: Chapman and Hall, Ltd. 1933. Price 20s.—It seems the general rule nowadays to publish American technical books in England and, presumably, English technical books in America, whether they are really suitable for the country or not. That is not to say that the book under discussion is not suitable for this country, for it is not improbable that it may prove quite popular. But for one at least of the purposes for which it was written in America it may become a source of error in this country. One of the author's aims was to give to the reader an engineering vocabulary and not all American terms are equally applicable in this country. In pursuance of this purpose most of the technical terms throughout the book are printed in a bold black type. The text throughout is descriptive rather than theoretical, as it is the belief of the author that a knowledge of the form and use of engineering devices should precede the study of the technical details of their design. As the book is concerned more particularly with power stations, steam is the predominating influence, as may indeed be inferred from the following list of chapter headings:—Power Generation and Sources of Power; Combustion of Fuels; Boilers; Boiler Details and

Accessories; Boiler-house Appliances; Power from Steam or Gas; Machine Details; Valves—Valve Gears and Governors. The book is profusely illustrated mainly by drawings and an index is included at the end.

Power Economy in the Factory. By J. C. Todman. London: Sir Isaac Pitman and Sons, Ltd. 1932. Price 7s. 6d.—This is another of the little Pitman technical manuals, published at a price within the reach of all. It is like many other books of the same class published by Pitman's, of a more or less elementary nature, and its writing was prompted by the author's opinion that in a great many and probably a majority of the factories at work to-day money is being wasted continuously by various losses in the generation and transmission of power. The first three chapters are devoted to simple mechanics, heat, and magnetism and electricity respectively. There follow chapters on furnaces, boilers, boiler-house measuring instruments, and the steam engine. Internal combustion engines, electrical generators, the control and distribution of electrical energy, and electric motors are dealt with in following chapters. In the remainder of the book its subject is further developed. Chapters on the improvement of power factor, power distribution, and the distribution of steam and gas are followed by further sections dealing with compressed air and hydraulic power. Power and the cost accountant and units of measurement bring the book to a close.

BOOKS RECEIVED.

Strömungsgesetze in rauhen Rohren. By Dr.-Ing. J. Nikuradse. Berlin: V.D.I. Verlag, Dorotheenstrasse 40, N.W.7. Price 5 marks net.

Report on Prevention of Dusting of Concrete Floor Surfaces. London: The Institution of Structural Engineers, 10, Upper Belgrave-street, S.W.1. Price 6d. net.

Eleventh Annual Report of the Safety in Mines Research Board, 1932. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 2s. net.

The Stresses in Aeroplane Structures. By H. B. Howard, B.A. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 20s. net.

Mitteilungen aus den Forschungsanstalten des Gutehoffnungshütte-Konzerns. Band 2, Heft 7. Berlin: V.D.I. Verlag, Dorotheenstrasse 40, N.W.7. Price 2·45 marks.

Handbook of Information and Indexed List of British Standard Specifications, July, 1933. London: British Standards Institution, 28, Victoria-street, S.W.1. Price 1s. net.

SIXTY YEARS AGO.

WORDS, particularly technical words, have a strange way of changing their meaning with the passage of time, or of being applied in one connection only to be forgotten and revived at some later date in an entirely different sense. Thirty years or so hence, the writer of this note, whoever he may be, will probably be speculating on the curious use in our pages of the word "aerodrome" to signify not a flying ground, but a flying machine. To-day, turning back to our issue of September 19th, 1873, we alight on two equally curious instances of philological transmutation. The first leading article in that issue bore the cryptic title "Calorimeter in Locomotive Engine Boilers." We have to confess to some measure of surprise that even sixty years ago the word "calorimeter" could be used, in a technical or scientific discussion, otherwise than as meaning an instrument for measuring quantities of heat. Yet, in our article it was clearly and specifically defined as signifying "the gross aggregate area of escape through the flues of a boiler." Our article was, in fact, concerned with current practice as regarded the proportioning of the cross-sectional area of the boiler tubes to the grate area in locomotives. Our second example occurs in a succeeding leading article entitled "Brindley's Dictum as to Rivers and Canals." Glancing down it the term *auto mobiles* catches our eye. It was not, however, employed to designate mechanically propelled road vehicles, but referred to one of three methods—the others being *vannes mobiles* and *hausses mobiles*—which had been in use in France for the previous seventy years for dealing with the flood waters of navigable rivers. The technical interest of neither leading article has survived. The argument of the first was based on the faulty, but, at that time, universally accepted belief that "the more slowly the heated gas can be made to traverse the tubes the better." The second dealt with Brindley's "celebrated maxim," to the effect that the use of rivers was to feed navigable canals. In a previous issue we had described this saying as being not far removed from nonsense, although it was often repeated as providing an instance of the mental vigour of an untutored genius. A correspondent had taken exception to our opinion and had maintained that Brindley's utterance contained profound wisdom. We replied that it might be so if the remark were confined to English rivers, but that Brindley, while he possessed strong mother wit, had had narrow opportunities for acquiring information and that his saying could not possibly be held to be applicable to many great rivers which, to him, could have been little more than names. . . . To round off our survey of the subjects which, at the moment, were engaging our attention, we may add that the title of a third leading article in the same issue was "The Kitchen Middens of London." This article is interesting to-day because of the picture which it presents of domestic sanitary conditions in the Metropolis sixty to seventy years ago. The cesspool had nearly disappeared, but the "dust pit," cleared by contractors at nominally frequent intervals, survived. We argued in favour of the abolition of fixed brick or wooden structures into which to shoot the household refuse, where it would await the uncertain and perfunctory attention of the dustmen, and their replacement by light sheet metal boxes—the dustbins of to-day, in fact—capable of holding not more than two or three days' "dust."

The Traneberg Arch Bridge, Stockholm.

◆

FOR many years the City of Stockholm has been extending its residential area westward. In Bromma, a district lying to the west of, and separated from, Kungsholmen by the Traneberg Sound, some 30,000 people have settled in the suburbs and garden cities which have grown up since the beginning of the present century when the Municipality of Stockholm bought large areas of land in the district. A large proportion of the residents have their daily work in the business quarters of Stockholm, and their only means of communication with the city is, at present, by way of a pontoon bridge, 187 m. in length and 8·5 m. wide, which spans the Traneberg Sound. The crossing of the Sound, one of the many narrow passages in Lake Mälaren (Fig. 8) has always been made by means of a pontoon bridge since the first of these was constructed in 1787. The present bridge was opened for traffic in 1914; it has a movable section which permits the passage of shipping through the Sound. The bridge, which carries two tramway tracks, is now too narrow to accommodate the rapidly increasing volume of traffic, and it is incapable in its present condition of carrying the heavy road vehicles and electric rail cars now in common use in the Stockholm district. The delays due to the opening of the bridge for shipping also result in inconvenience to road traffic.

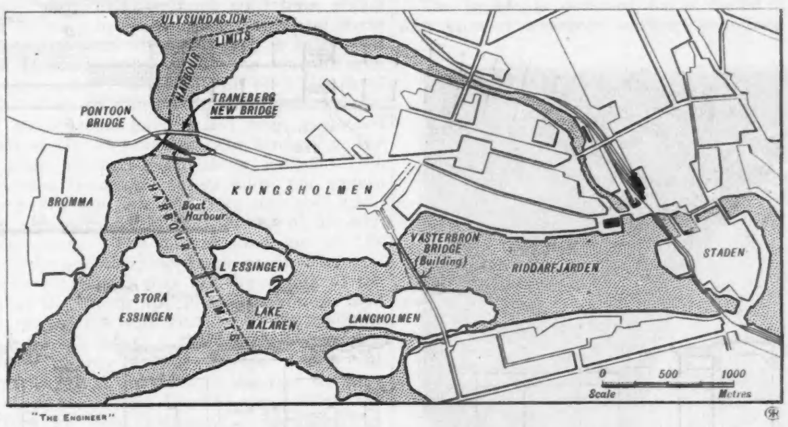

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FIG. 8—PLAN SHOWING POSITIONS OF NEW BRIDGES

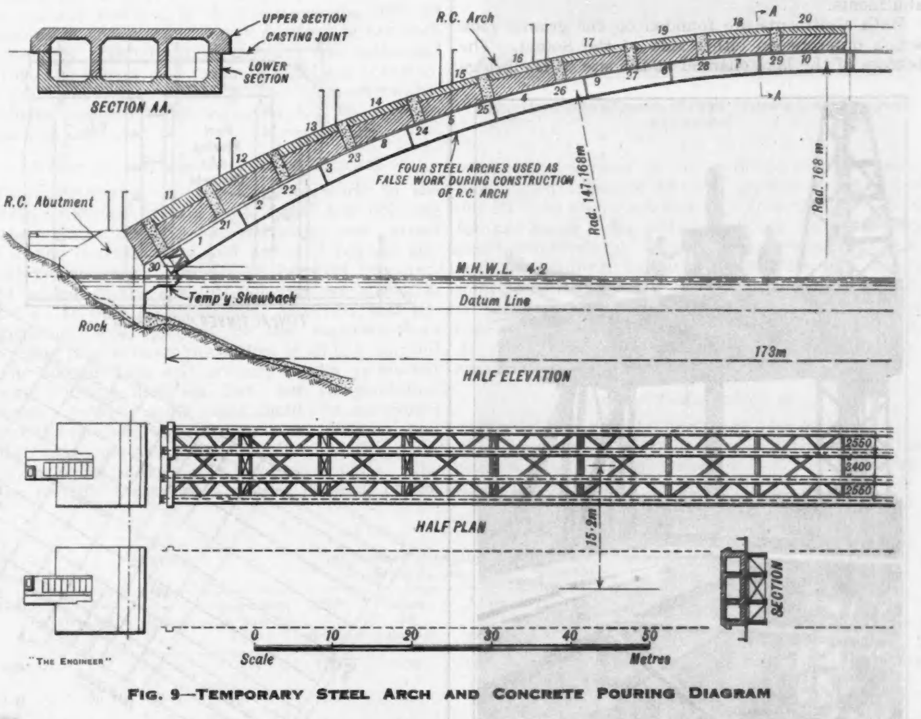

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FIG. 9—TEMPORARY STEEL ARCH AND CONCRETE POURING DIAGRAM

Early in 1931 the Stockholm Harbour Authority decided to replace the pontoon bridge by a single span reinforced concrete arch bridge over the waterway with viaduct approaches which would be sufficient for all the requirements of modern road traffic and provide also for two lines of suburban electric railway track. It should be explained that the Harbour Authority is responsible for the construction of all road bridges crossing the several arms of the sea, and the channels of Lake Mälaren within the limits of the harbour area. Although the Harbour Authority is responsible for the design and construction of such bridges, the cost of the work is borne by the City Authorities, and the expense is, therefore, not a burden which has to be borne by the shipping trade of the port.

VASTERBRON BRIDGE.

It may here be mentioned that the Harbour Authority is, concurrently with the building of the Traneberg Bridge, building another bridge across the Sound which separates Kungsholmen from Langholmen. This bridge—the Vasterbron (see Fig. 8)—consists of two steel arches spanning the waterway with a pier in the middle of the channel and approach viaducts and forms a part of the scheme of new road connections between Kungsholmen and Södermalm. The two arches have spans of 168 m. and 204 m. respectively. The total length is about 600 m.

TRANEBERG BRIDGE.

The new Traneberg Bridge (see page 258 and Figs. 9, etc.) is situated about 120 m. north of the pontoon bridge, and has a total length, including the viaduct approaches, of 580 m. It is of special interest not only because the arch has a greater span than any other reinforced concrete arch yet built, but also on account of the novel method of erection employed by the builders. The length of the viaducts is 215 m. on one side, and 145 m. on the other. The reinforced concrete arch over the waterway has a theoretical span of 181 m. and a clear span between abutments of 178·4 m. The rise of the arch is 27 m., which gives a clear headway for shipping of 26 m. above mean high-water level over a width of 45 m. The bridge has an overall width between balustrades of 27·5 m., of which 12 m. are devoted to roadway, 8·5 m. to the two tracks of the Suburban Electric Railway, and the balance of 7 m. is occupied by two footpaths and two bicycle tracks (Fig. 10). The road surface has a gradient of 1 in 30 in each direction from the centre of the arch span. Portions of each of the two approach viaducts are built to a curvature in plan of 300 m. radius.

The arch span consists of twin reinforced concrete arches placed at a clear distance from each other of 6·2 m. Each arch has a width of 9 m., and a depth of 5 m. at the abutments and 3 m. at the crown. The arch is designed as a hollow rectangular reinforced structure with two dividing walls. The slab thicknesses at the crown are 0·45 m. for the top slab and 0·50 m. for the lower slab. The side walls are 0·50 m. thick, and the division walls 0·40 m. The dimensions of the slabs and vertical walls are increased towards the haunches. The enclosed rectangular spaces formed by the walls and slabs of the arch ribs will be utilised for gas and water mains, and electric supply cables. The middle space in each arch is continued through the concrete abutments.

Both abutments are founded on the granite rock which outcrops on either side of the Sound. The bottom of the lake channel at the site of the bridge between the abutment foundations consists of soft clay and gravel or sandy clay overlying the granite rock, which, at its lowest level, is 33 m. below mean high-water level. The depth of water in the middle of the Sound is about 16 m.

The deck of the bridge is carried on a system of welded steel longitudinal and transverse girders, supported by thin reinforced concrete pillars which have the same width as the concrete arches and a maximum thickness of 0·9 m., and, at the crown of the arch span, by rolled steel joists. The approach viaducts are constructed in a similar manner to the superstructure of the arch span, the supporting columns or piers being similar to those which rise above the arch, except at the western end of the approach on the Traneberg side, where the superstructure is of reinforced concrete carried on rectangular columns of similar material.

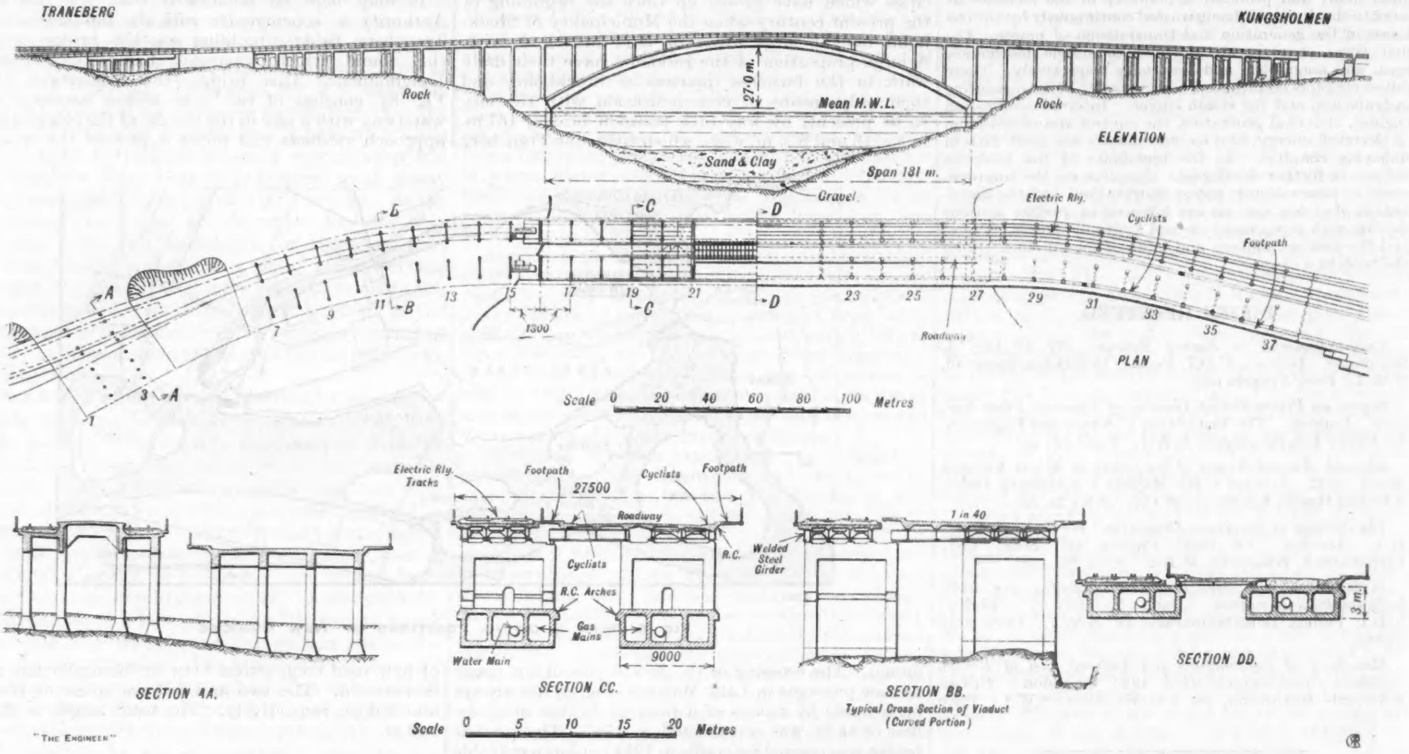
TRANEBERG
KUNGSHOLMEN
Rock
27·0 m.
Mean H.W.L.
Rock
ELEVATION
Sand & Clay
Span 181 m.
Gravel
Electric Rly.
Cyclists
Footpath
A
B
C
D
1
3
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
1300
Roadway
PLAN
Scale 0 20 40 60 80 100 Metres
Electric Rly. Tracks
Footpath
27500
Cyclists
Footpath
Roadway
Cyclists
R.C.
R.C. Arches
Gas Mains
Water Main
9000
1 in 40
Welded Steel Girder
3 m.
SECTION AA.
SECTION CC.
SECTION BB.
Typical Cross Section of Viaduct (Curved Portion)
SECTION DD.
Scale 0 5 10 15 20 Metres
"THE ENGINEER"

FIG. 10—TRANEBERG BRIDGE—PLAN, ELEVATION, AND SECTIONS

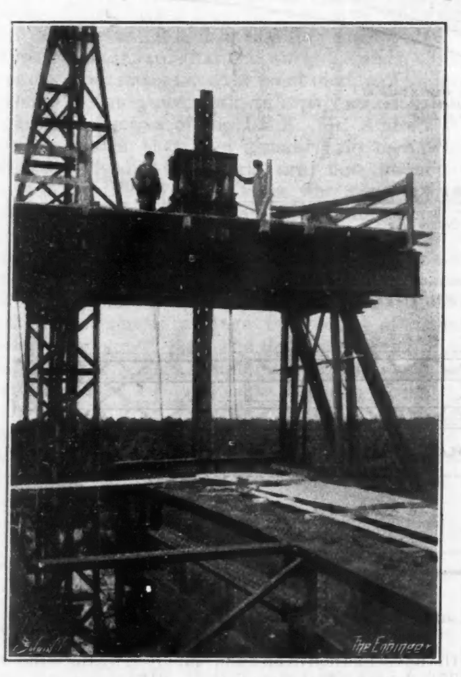
The Engineer

FIG. 11—HYDRAULIC JACKS ON TOWER FOR RAISING STEEL ARCH

STEEL ARCH FALSE-WORK.

The false-work or scaffolding employed for the construction of the twin concrete arches consisted of a steel arch which, after having been used for the first concrete arch, was moved to the position of the second arch and used over again. This temporary arch (Fig. 9) was built up of four riveted steel plate arch ribs, 2·4 m. deep, spaced apart transversely 2·55m.—3·40m.—2·55m. The arch ribs were continuous from abutment to abutment and had no hinges. The span of the steel arch, measured to the centres of the supports, was 172 m. The abutments for the steel arch were provided by temporary concrete skewbacks cantilevered out from the permanent abutments of the concrete arches below the permanent skewbacks. The four ribs of the steel arch were connected together and stiffened by angle bar cross bracing (Fig. 9).

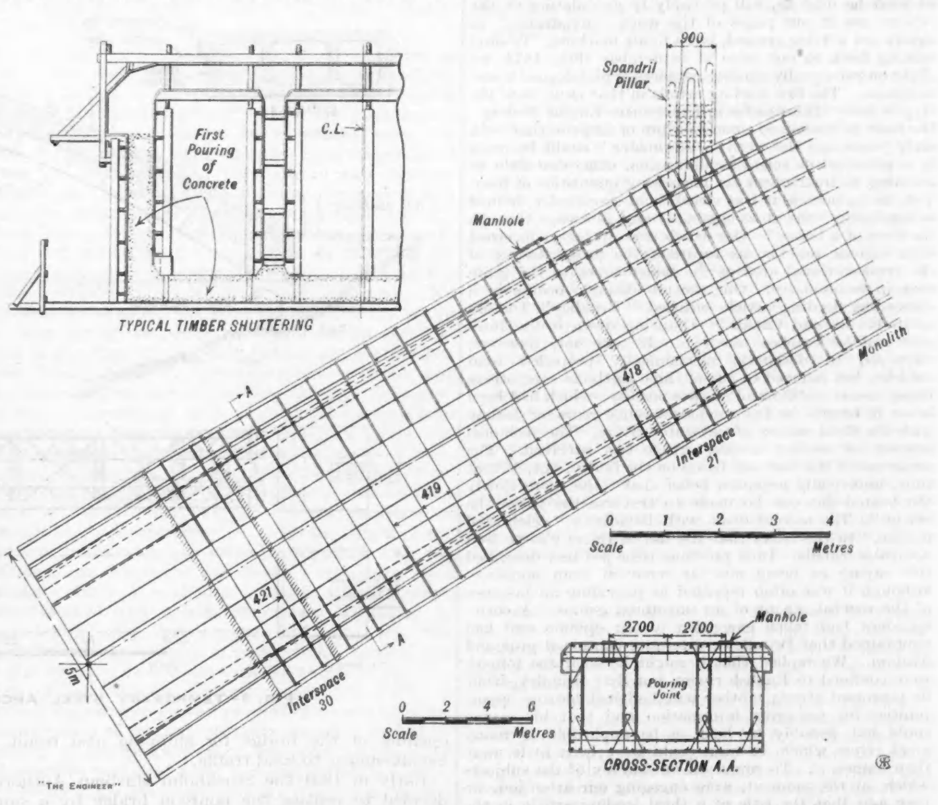
First Pouring of Concrete
C.L.
TYPICAL TIMBER SHUTTERING
900
Spandril Pillar
Manhole
Monolith
418
Interspace 21
419
421
A
5m
Interspace 30
Scale 0 1 2 3 4 Metres
Scale 0 2 4 6 Metres
2700 2700
Manhole
Pouring Joint
CROSS-SECTION A.A.
"THE ENGINEER"

FIG. 12—DETAILS OF STEEL REINFORCEMENT AT HAUNCH OF ARCH, AND TYPICAL SHUTTERING

In preparing the scheme for the erection of the bridge before tenders were obtained, consideration was given to a scheme of false-work comprising temporary steel arches of three spans, respectively 24 m., 120 m., and 24 m., supported on temporary foundations in the channel. This design was suggested, as the preliminary estimates had shown that steel false-work in one span would probably be more expensive than the alternative. When tenders for the work were invited, tenderers were also at liberty to submit further alternative proposals for the temporary works, and it was then found that a single steel arch span would cost about the same as three arches. As a single-span temporary arch offered several practical advantages, a tender was accepted on this basis of construction. It may be remarked that the alternative adopted has proved somewhat more expensive to the contractors than had been expected.

The steel arch ribs were built up at the works and dispatched in sections of 11 m. length and transported by barge to a wharf 2 kiloms. from the bridge. The sections were there riveted together to form half-spans of two ribs in each (Fig. 2, p. 258), and were then brought to the site of the bridge on two sections of a small floating dock. A steel tower was then built up on the deck of two other sections of the floating dock, which were moored in the correct position midway between the abutments (Figs. 2 and 3). The four half-spans, placed successively on the two sections of the floating dock, were manœuvred into position between the abutments and the floating erection tower, the skewback end of each semi-arch being placed in contact with a temporary support on the abutment. The crown end of each half-span was suspended from the tower by link plates and raised by means of hydraulic jacks (Figs. 2 and 11). When all the four half-spans had been lifted to the correct height, they were coupled together with a temporary ball link at the crown, and, after careful adjustments had been made with hydraulic jacks at the abutments (Fig. 5) and the final bearings had been built in, the arches were riveted together at the crown. Finally, the cross bracings between the two pairs of ribs were erected and riveted (Fig. 3).

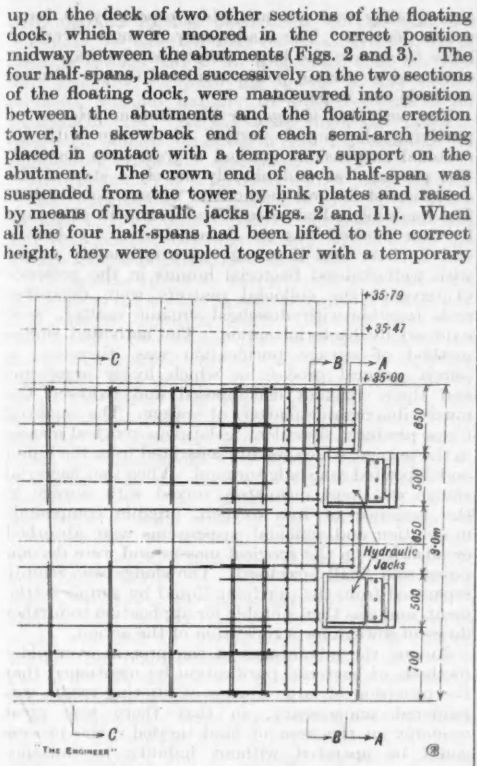

FIG. 13—DETAIL OF REINFORCEMENT AT CROWN OF ARCH

CONCRETING OF ARCHES.

The concreting of the arches was carried out in two stages, first, the lower slab and the side walls, and secondly, the inner partition walls and the top slab. The concrete was poured in monolithic sections of lengths varying from 7·2 m. to 8·5 m., and in a suitable order for equalising the loading of the steel arches (Fig. 9). An interspace of 1·2 m. was left between the monolithic sections to provide for shrinkage. These joints were not filled until the concrete in the monoliths had set and hardened and was at least eight days old.

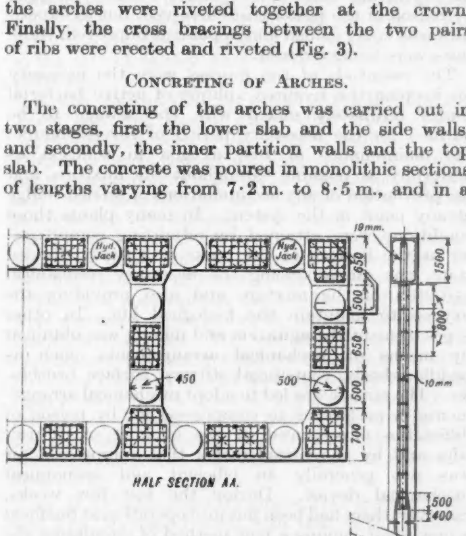

FIG. 14—HYDRAULIC JACKS AT CROWN OF ARCH AND DETAILS OF PILLARS

All the shuttering and form work for the concrete was of timber; a typical section of the form work is shown in Fig. 12, and a view is reproduced in Fig. 6.

REINFORCEMENT.

The bridge is not very heavily reinforced as tension will occur seldom and only in the lower slab at the abutments. In each arch there is a reinforcement of 108 round M.S. bars, 22 mm. diameter, which are lapped in the construction interspaces without hooks. In addition there is some reinforcement at right angles to the main bars. Details of portions of the steel reinforcement are reproduced in Figs. 12, 13, and 14. On an average the steel reinforcement is about 60 kilos. per cubic metre of finished concrete.

REMOVAL OF CENTERING.

The concreting of the first arch was completed about Christmas, 1932, and about two months later, in March, 1933, the temporary steel arch was removed in the following manner:—Eighteen hydraulic jacks, each of 330 tons capacity, were placed in position in recesses formed in the crown of the arch (Figs. 7, 13 and 14). Pressure was applied by these jacks in a direction parallel to the line of thrust at the crown until the arch had lifted about 0·17 m. at the crown and the crown had opened 0·11 m. at the top and 0·10 m. at the bottom. The horizontal pressure thus applied amounted to about 6000 tons, which was about 700 tons in excess of the horizontal stress due to the dead load when the arch is in normal condition. It was then found that the concrete arch had been raised from the steel arch on a length of 20 m. at the crown and 25 m. adjoining the abutments. Electrical strain-stress gauges had been concreted in the arch at the abutments. The stresses in the concrete were registered on these gauges; the stress increased from zero to 49 kilos. per square centimetre in the top slab, and from zero to 3 kilos. per square centimetre in the bottom slab of the arch at the abutments. The gauges used are of the "Carlson" type and also record temperature changes.

It may be mentioned that the depression of the steel arch at the crown due to the maximum load supported during the construction of the concrete arch had been calculated to be 0·20 m. Actually, the measured depression was 0·18 m. After the steel arches had been unloaded in the way we have just described, they were lowered away from the concrete arch by eight hydraulic jacks placed at the abutments and traversed on rollers to the parallel position for the construction of the second concrete arch. Hydraulic jacks were used for moving the steelwork to the second position (Figs. 4 and 15). The temporary steel arch, together with the timber staging carried by it, weighed about 1200 tons.

In May, 1933—that is, about two months after the steel arch had been removed from the first concrete arch—the crown of the latter was lowered about 0·082 m. by applying a negative bending moment at the crown so as to compensate for the increased stresses due to weight of roadway, live loads, and temperature variations. This bending moment was obtained by applying four additional hydraulic jacks at the crown section, bringing the total number of jacks up to twenty-two of 330 tons each. The moment was produced by the jacks exerting different pressures at the top and lower portions of the arch respectively. The bending moment was estimated at 1590 ton-metres, and, when it had been obtained, the joint was concreted in. A short time afterwards the jacks were run down, removed, and the recesses filled with concrete.

VIADUCT AND ARCH SUPERSTRUCTURE.

The construction of the concrete work in the spandril columns of the arch span, the columns of the viaduct and the superstructure was carried out in the ordinary way and does not require any detailed description. Details of the steel reinforcement of one of the spandril columns are shown in Fig. 14. It may be mentioned, however, that the longitudinal steel girders of the superstructure rest freely (but without possibility of sliding motion) on the column tops and are not rigidly connected thereto. The pillars, in fact, act as pendulum columns. Another point which should be mentioned is that the roadway superstructure on the arch span is discontinuous along the middle line (Fig. 10), the joint being masked by a steel cover plate. The reason for this construction is that one-half of the roadway rests entirely on one concrete arch, but the other half is carried by both arches. The bridge being aligned almost due east and west, there may be at certain times an appreciable elevation of the crown of the south arch above the level of the north arch owing to temperature differences, and the articulation of the road surface provides for this possible inequality. This articulation also provides for the unsymmetrical distribution of the live loads on the bridge, a factor of even greater practical importance than the temperature differences.

Provision is made for expansion and contraction of the bridge floor system by means of expansion joints at the points 6 and 38 and at pillars 16 and 27 (see plan, Fig. 10). At pillars 16 and 27 the supports for each longitudinal girder consist of roller bearings, and at points 21 and 22 there is also a joint in the floor system.

CONCRETE SUPPLY.

The whole of the concrete used in the bridge was gauged and mixed under standardised conditions in a central concrete factory in Kungsholmen, and transported to the works in portable containers on motor lorries. The concrete and other materials were distributed to the working positions on the arch and in parts of the viaduct by a wire ropeway crossing the Sound on the line of the bridge.

TRAFFIC LOADING.

The bridge is designed for a traffic loading of four lines of transport vehicles, including a 20-ton road roller, abreast on the carriage roadway, each line corresponding to an ideal loading consisting of one 11 tons axle load and two linear loads of 0·50 ton per lineal metre of the traffic file spaced 1·7 m. apart transversely. For the cycle tracks and footpaths a uniform loading of 400 kilos. per square metre is allowed. The loading provided for on the two tracks of the suburban railway is a 68-ton motor coach with three trailing coaches of 40 tons each. All the above loads are increased by a suitable allowance in each case for impact.

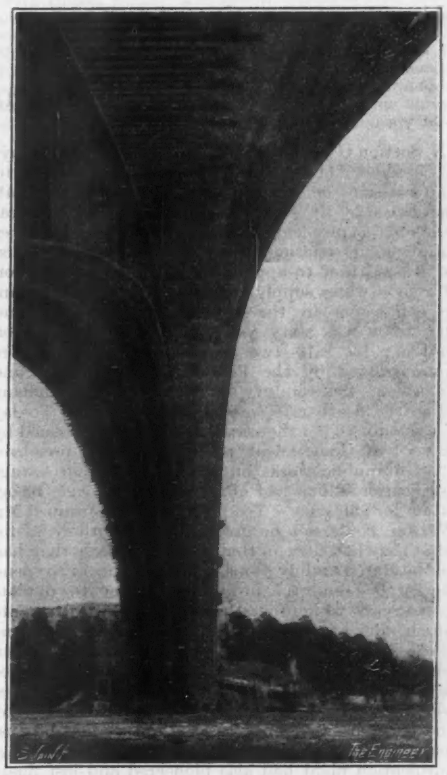

FIG. 15—TRAVERSING STEEL ARCH TO SECOND POSITION

CONCRETE MIXTURES, &c.

The following table shows the proportions of the different mixtures of concrete used in the bridge, the compressive strength obtained and the maximum stress allowed for in designing the structure :—

Cement, kils. per cu. m.	Mixture.			Compressive strength in kilos. per sq. cm.			Permissible stress, kilos per sq. cm.	Position of concrete.
	Cement.	Sand.	Stone size in mm. 7–70.	After 7 days.	After 28 days.	After 90 days.		
300	1	3·0	3·3	160	300	330	60	Abutments of the viaduct approach (Kungsholmen side). Columns
330	1	2·9	2·7	180	320	360	60	Bridge floor
350	1	2·7	2·5	200	340	390	80	Water pipe chambers in the arch abutments
365	1	2·6	2·5	220	430	450	100	The arches and their abutments
400	1	2·2	2·2	250	450	480	120	Portion of the crown of the arches

QUANTITIES OF MATERIALS.

The total amount of concrete used in the construction of the bridge will be about 22,000 cubic metres. The weight of the steel reinforcement is 1400 tons, and of the welded steel girders and joists in the superstructure 1300 tons. The temporary steel arch structure weighed about 1000 tons, and 60,000 square metres of timber shuttering were used for the concrete construction. The total cost of the bridge, including the approach viaducts, will be about 5,300,000 kroner (about £290,000 at par).

Conclusion.

On page 258 and elsewhere we reproduce several photographic views of the bridge taken during construction. Fig. 2 is a view of the floating erection tower with one semi-arch raised and another being lifted. Fig. 11 shows the hydraulic jacks and link plates at the top of the erection tower, and Fig. 3 is a view of the arch when all the four parts were in position. Fig. 5 shows the steel arch being adjusted at one of the abutments by hydraulic jacks, and Fig. 15 is a view taken from the ice in the channel beneath the bridge while the temporary steel arch was being traversed to the second position. Another view of the traversing operation is shown in Fig. 4. Fig. 6 is a view of the first concrete arch during construction. Fig. 7 is from a photograph taken inside one of the rectangular compartments at the crown of the concrete arch while the hydraulic jacks were being pumped up. A view of the bridge works in July, 1933, is shown in Fig. 1.

The bridge is expected to be opened for traffic in the early summer of 1934; when we inspected the works at the end of June last, the erection of the superstructure of the viaduct was in progress, and the construction of the second concrete arch was well advanced. The bridge was designed by, and its construction is being carried out under the supervision of, the Engineering Department of the Stockholm Harbour Board. We are especially indebted to Major Ernst Nilsson, the engineer responsible for the design, for the use of plans and photographs, and for the information upon which our description of the works is based. The construction of the bridge is being carried out departmentally by the staff of the Stockholm Harbour Board, no general contractor being employed.

Sewage Disposal.

BRITISH ASSOCIATION, LEICESTER.

In Section G of the British Association on Monday, September 11th, the whole morning was devoted to a discussion on sewage treatment and disposal, introduced by Mr. J. D. Watson, who in a brief general talk on the problems associated with a good water supply in its relation to sewage treatment and disposal, said that to appreciate what the introduction of a good water supply to a great town might mean, we could compare the state of our largest Midland city as it was sixty years ago with its condition to-day. In 1870 two Government officials were commissioned by the Privy Council to write and report on the sanitary condition of Birmingham, when the death rate was 23 per thousand. To-day it was only 10 per thousand, and the report issued by those two Government officials was the precursor of great public works on water supply and sewage purification which had obtained a world-wide recognition for efficiency. Too much credit, continued Mr. Watson, could not be given to local authorities for what they had done in that respect, because they had not hesitated unduly to make experiments or to spend money on doubtful projects in order to obviate nuisances or to improve the condition of streams into which effluents were discharged. Birmingham and Sheffield were notable examples of that. To their credit, he said, those local authorities were prepared to face criticism rather than perpetuate a process which could be regarded as inferior. Nor had failures and losses been confined to local authorities, because manufacturers of machinery associated with sewage purification plant had also pioneered and lost financially as the result of their zeal for progress. Bio-aeration had proved to be an easy way of controlling the smell and fly nuisance without impairing efficiency or interfering with oxidation. That process was generally less costly to instal than the bacteria bed process, but maintenance costs were higher. There was one thing, however, which should not be overlooked, namely, bio-aeration plants required more scientific management than was necessary in the case of the bacteria bed or of land irrigation.

Commenting upon the remarks of the Royal Commission on Sewage Disposal in 1905 to what is now termed "sludge digestion"—a natural and odourless method of treating sludges—Mr. Watson said that with the exception of Birmingham, where the work was done on a large scale, that method of treatment had not been adopted in this country until recently. It was recognised by scientists to be reliable, but in certain circumstances it might not be economical. Nevertheless, it would be doubtful economy if preventable stench were allowed to persist or to interfere with the health and comfort of the people. As a possible pecuniary advantage of that process, it was pointed out that it yielded a valuable gas, capable of generating power, and that the dry residuum might be used as an organic base for a fertiliser, since it was devoid of fat and possessed from 2½ to 4 per cent. of nitrogen. Mr. Watson also recalled that he himself brought to the notice of the British Association in Edinburgh in 1921 the potential value of methane gas produced by sewage sludge when a 25 H.P. engine had just been started in Birmingham using that gas. Since that time sewage gas engines had been installed up to about 1000 H.P.

Finally, Mr. Watson in his introduction to the discussion, said that whilst public opinion was laying greater stress upon the need for conservation of our comparatively few pure streams, it was also beginning to realise that too many small sewage works were being dotted over the country. The time had come, he said, when the administrator should see that fewer, better, and more scientifically designed and managed works were substituted wherever possible. The first example of co-ordination amongst local authorities was that of Croydon and fourteen other towns which united to create a scheme of sewage and water supply. That example was followed by others, but it had not been popular with authorities unless it could be shown that they would not suffer financially. The Local Government Act of 1929 encouraged local authorities to take a far-seeing view and invited the County Councils to help to overcome difficulties, which without that help could not be dealt with. At the instigation of the great majority of the local authorities in West Middlesex, the Middlesex County Council promoted a Bill in Parliament to construct intercepting sewers to convey to one site for purification, sewage and surface water equal in volume to 240 gallons per head per day of a potential population of two million people. In addition to arresting the pollution of a number of rivers, the immediate effect of that scheme would be to abolish twenty-seven public sewage works as well as several private works. That Bill became an Act in 1931, and the authorised works, now in course of construction,* ought to be completed before the end of 1935.

Mr. H. F. Atter (Clerk and Solicitor to the West Riding of Yorkshire Rivers Board) followed with a paper on "The Legal Aspect of River Pollution, with Special Reference to the Rivers Pollution Prevention Acts," pointing out that whilst the Joint Advisory Committee on River Pollution in 1928 reported that there was no lack of administrative authority for enforcing the law, it was admitted on all hands that many of our rivers were seriously polluted, and that the law designed to prevent avoidable contamination was to a large extent not put into operation.

Dealing with the purification of sewage by natural processes, Professor W. E. Adeney and Dr. A. G. G. Leonard gave the results of laboratory experiments which elucidate certain fundamental principles involved in the aerobic purification of sewage liquors. By the extraction and analysis of the gases occurring in polluted waters undergoing oxidation, it had been possible, they said, to study the changes accompanying the destruction of impurities occurring in true and colloidal solution in such waters. Thus it had been established, within the limits of experimental error, that equal volumes of the same polluted water undergoing aerobic fermentation consumed equal quantities of oxygen, and gave rise to products which were constant in quantity, provided always that dissolved oxygen was present in excess. The rates of solution of oxygen and nitrogen by fresh and salt waters had been determined, and a well-defined mathematical equation obtained connecting rate of solution, surface exposed, volume of water, temperature and degree of saturation. Air dissolved by water at its surface did not remain concentrated in the surface liquid, but sank more or less rapidly, causing aeration to depths of at least 10ft., a process for which the term "streaming" was adopted by the authors. It was added that all the sewage of Sheffield is now being treated by the bio-aeration process, using mechanical agitators only, with most successful results, that method of the destruction of organic matter being essentially one of oxidation which, under aerobic conditions was effected by bacteria utilising the oxygen dissolved in the contaminated liquors.

Mr. John Haworth, M.B.E., the general manager of the sewage disposal department, Wincobank, Sheffield, contributed a paper in which he discussed the more modern methods of sewage purification and the steps by which they were developed, and described briefly a plant of the activated sludge type in operation at Sheffield, in which mechanical arrangements for agitation and mixing are adopted instead of compressed air.

In the early part of the paper he pointed out that if adequate areas of suitable land could be obtained and properly operated, the land treatment of sewage would still be an economic and effective method. Unfortunately, however, the necessary land of suitable quality was not available, especially in large urban districts. The inadequacy of most rivers or lakes to receive the large quantities of sewage concentrated at certain points rendered simple dilution methods also impossible.

The activated sludge, or bio-aeration process, of purifying the liquid portion of sewage with its colloidal suspensions marked a great step forward. The process was undoubtedly merely a step in the evolution of natural methods of sewage purification. The fundamental advance in the treatment of sewage by that method was the demonstration by Ardern and Lockett that if sewage were intimately mixed with well-oxidised bacterial humus in the presence of oxygen, the colloidal matters were deposited and, together with dissolved organic matter, were oxidised by bacterial action. The activated sludge method of sewage purification was, therefore, a purely natural process in which living organisms and their enzymes decomposed and oxidised the putrescible organic matters of sewage. The bacterial forms produced flocculent, gelatinous zoogleal masses in the sewage, which readily separated from the liquid and deposited as a sludge or mud. When that bacterial sludge was kept intimately mixed with sewage in the presence of free oxygen, organic compounds in solution and colloidal suspensions were absorbed or adsorbed on the zoogleal masses and were decomposed and finally oxidised. The sludge was readily separated from the purifying liquid by simple settlement, and was then suitable for application to further doses of sewage for a repetition of the action.

Among the advantages of the process over older methods of bacterial purification he mentioned that the provision of large masses of filtering media was rendered unnecessary, so that there was great economy in the area of land needed; the process could be operated without liability to nuisance from flies or objectionable odours, and the purification effected was equal to or greater than that effected by any other process and could be carried to any degree of efficiency required. The initial costs of installing plant operating the process were usually less than those for other types of plant; the operating costs were possibly slightly higher, by reason of the power costs involved, but as experience was being gained and apparatus improved, those costs were being reduced.

The essentials of the process were the necessity for keeping the required volume of active bacterial sludge intimately mixed with the sewage to be purified for the necessary period of several hours; the maintenance of free oxygen in solution as uniformly as possible throughout the mixture, and the prevention of any accumulations of settled sludge at any point in the system. In many plants those conditions were attained by admitting compressed air at the bottom of the tanks in a finely divided state, the air producing the necessary mechanical agitation of the mixture and also providing the oxygen to maintain the biological life. In other types of plant the agitation and mixing was obtained by means of mechanical arrangements, such as paddle wheels, centrifugal stirrers, surface brushes, &c. The author was led to adopt mechanical arrangements in preference to compressed air by reason of difficulties experienced in the choking of diffuser tiles and by the consideration that compressed air was not generally an efficient and economical mechanical device. During the last few weeks, however, there had been put into operation at Sheffield a new plant, having a new method of circulating the water round the channels and of obtaining the necessary aeration. The usual methods for preliminary treatment of the sewage were adopted, the sewage being passed through detritus tanks and screens, followed by Dortmund type settling tanks to remove the grosser solids. The settled sewage then passed to an aeration tank possessing novel features. Instead of paddle wheels, which had the effect of lifting the water in successive stages to create circulation, the floor of the channels was graded to such a fall that the lift desired to give the proper circulation was obtained in one stage by a suitable pump; a duplicate pump was provided as a standby. Each pump, which was of the axial-flow type, was rated to deliver 8600 gallons per minute against a static head of 4ft. 6in., and was direct-coupled to a 22 B.H.P. vertical motor working at 90 per cent. full load. The plant might be compared to an artificial turbulent river, about a mile in length, carrying the amount of bacterial sludge required to purify 500,000 gallons of sewage per day. The necessary aeration was obtained at the turbulent points in the stream.

The author mentioned also an interesting modification of the bio-aeration process which had been adopted at Birmingham. In that process sewage liquor was partially treated with activated sludge before application to percolating filters, thereby permitting much larger volumes of liquor to be applied to the filters than would be possible otherwise. In that case it was necessary to revivify or recondition the sludge after each operation by prolonged aeration in small bulk.

At Bradford, also, there was in progress an experiment in which the effluents from bacterial filters, produced from a strong trade sewage, were being impounded for a prolonged period in large lakes before discharge to the river. Already a remarkable flora and fauna was being developed in those lakes, with marked further purification of the effluents.

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* See The Engineer, March 17th, 1933.

Finally, he asserted that bio-aeration methods of treating sewage had so far progressed that methods were available for purifying sewage to any degree required, without liability to nuisance, and at an economical cost. At the same time, the problem presented almost limitless fields for research in engineering, chemistry, and biology.

Mr. Frank C. Vokes followed with a paper entitled "The Treatment and Utilisation of Sludge," in which he dealt with the plant of the Birmingham Tame and and Rea District Drainage Board, which treats the sewage from a population of 1,200,000.

The process adopted, was, he said, to remove the sludge from the sewage as soon as possible and isolate it in separate digestion tanks. The operations were conducted in two stages. In the primary tanks the sludge was retained only so long as it was digesting vigorously and giving off gas. In the secondary tanks, the action was largely physical, taking the form of the extrusion of bound water. Inert sludge was then deposited and much of the separated water could be decanted off. The sludge was pumped on to drying beds, and some of it was sold to fertiliser manufacturers. Gas collectors were provided on the primary tanks and the gas was composed of approximately 60 per cent. methane, 29 per cent. CO_2, and 2 per cent. nitrogen. It had a gross calorific value of 685 B.Th.U. per cubic foot, and a generating station containing gas engine aggregating 950 B.H.P. utilised that gas for the generation of electricity, which was used for driving the plant at the Saltley works. The plant consumed about 56,000,000 cubic feet of gas per annum, and generated approximately 2,330,000 units of electricity.

At Yardley the Drainage Board had a works which received the sewage from a population of approximately 100,000, and the sludge digestion process had also been adopted there. In that case, owing to the small power requirements, the gas was mainly used for heating the sludge, and it had been found that the increased rate of digestion obtained by that means had allowed of a very considerable reduction in the capacity of the tanks, as compared with what would have been necessary had no heating plant been installed. The surplus gas was used to drive gas engines aggregating 46 B.H.P., which, as in the case of Saltley, generated electricity for works purposes.

It was claimed that the works of the Birmingham, Tame and Rea Board, where that process was in operation, had been working for a sufficient length of time to prove that by digesting the sludge, collecting the gas and utilising it for the generation of power, and for maintaining the sludge at a uniform temperature throughout the year, the modern sewage works could be independent of any outside source of power and was capable of providing the fuel for the whole of its own requirements.

The final contribution was by Mr. H. R. Lupton, who described in considerable detail machinery for dealing with sewage. This was intended rather as an appendix to the descriptions by other authors of the processes themselves, and was admittedly little more than a mere list of types of apparatus used for the purpose of treating sewage from the raw state. At the same time, attention was drawn to the principal points of interest in the various types of machinery described.

Mr. H. C. Whitehead (Engineer, Birmingham, Tame and Rea Drainage Board), said that in this country, at such centres as Sheffield, Birmingham, and the Potteries, purified sewage effluent was being used for trade purposes. He was not at all sure that we should not have to extend that practice further before long, and carry sewage purification to a degree at which the water could be safely used for trade purposes on a much larger scale. In the Ruhr sewage from a population of 1½ million people was mingled with the water supply to a population of 2½ millions, and four or five years ago he had been told that that water was used three times before it reached the Rhine. Londoners would apparently regard that as a state of affairs that could not be tolerated.

Mr. A. T. Gooseman (Leicester City Engineer) referred to experiments that had been carried out in Leicester to avoid the nuisance from screenings, both on the works and whilst being carted through the streets, the result being a process which he claimed to be a great advance upon disintegration. In that process—in which Leicester had been the pioneer—the screenings were discharged on to an endless belt and carried by a bucket elevator to a hopper and then discharged through a shoot into a digester. In that digester the screenings were cooked for from six to eight hours, the result being a valuable manure and the abatement of all nuisance. Originally it cost £300 per annum to dispose of the screenings, but after taking into account interest and depreciation on the plant a profit of £300 per annum was actually being made. The manure was fetching 5s. per ton, but the actual value was much higher, and he fully anticipated that when it was suitably advertised double that price would be obtained for it. He suggested the use of that system for seaside resorts as a means of eliminating the complaints so often made of the filthy state of the sea at the point of sewage discharge. Referring to the Leicester sewage works, Mr. Gooseman said they had cost £640,000, and pumped 36 billion gallons of sewage annually against a static head of 170ft. Some of the pumps, which were driven by steam, had been in use for forty years, and were still operating with every satisfaction. Others had been converted to electrical operation, but he did not care to risk the conversion of all the pumps, because he still regarded electricity supply as having elements of uncertainty, and could not afford to have those pumps inoperative for five minutes. He claimed that Leicester was getting results equal to any in the country and better than many.

Mr. F. R. O'Shaughnessy called attention to the changed mental attitude towards sewage purification in America in recent years, where they were actually reverting to mechanical filtration—giving up digestion—with incineration of the resultant sludge. He disagreed with certain statements made in the paper by Professor Adeney and Dr. Leonard. The suggestion that the humus in the separate digesting tank in the anærobic digestion process played a substantial part in preventing an offensive odour did not seem to him adequate, his own view being that the biochemical change brought about by anærobic digestion was entirely unconnected with the offensive odour which would be produced automatically if the material was left to itself. He also differed from those two authors in the view that ærobic digestion took place in two stages. In his view the whole process, from beginning to end, was a continuous one, and in the early stages there was a rapid elimination of non-nitrogenous material. Indeed, there was a good deal of evidence to show that in that process the nitrogen possibly played the part of a catalyst which took up oxygen and transferred it from the atmosphere and water to the non-nitrogenous material.

Professor F. G. Baily drew attention to the dirty condition of some rivers and lakes in Scotland, and said the trouble was that the Act of 1876 could only be put into operation, in fact, by those who were the chief sinners, viz., the local authorities, which were largely composed of the manufacturers who put dangerous trade wastes into the streams. The conditions in some cases were scandalous, and the streams were little better than open sewers. Whilst the position remained that local authorities had to put the Act in operation against themselves, there did not seem much hope of improvement.

Mr. F. T. K. Pentelow, of the Ministry of Agriculture and Fisheries, but who spoke in a private capacity, disagreed with the suggestion by Mr. Watson that there should be concentration of sewage disposal in large works, as compared with a considerable number of smaller works, in as much as the purity of river water depended on the relation of volume of sewage discharge and volume of river. If a number of towns of, say, 10,000 inhabitants, had their own sewage works, the discharge into the river would be comparatively small, and any deficiency in the purification plant could be made up for by the purifying action of the river. If, however, the sewage from a number of such towns was collected and dealt with at one works, and there was any deficiency in the sewage purification plant, the discharge of effluent would overtax the river at the point of discharge. That, at any rate, was a point to be borne in mind.

The President drew attention to the temperature of the exhaust gases of the engines using sewage gas, mentioned by Mr. Vokes, viz., 1130 deg., and contrasted that with the very much lower exhaust gas temperatures with gas engines generally and the figure in the B.S.I. specification of 370 deg., the object being to get as high a combustion efficiency as possible, and consequently a high efficiency.

The authors then briefly replied to the discussion.

Dr. Leonard said the matters to which Mr. O'Shaughnessy had taken exception in the paper by Professor Adeney and himself had been the subject of most careful experiment, and although in some respects the conclusions were a matter of speculation, the speculation was not unreasonable. In the same way it was difficult to contradict the suggestion that aerobic digestion was a one-stage and not a two-stage process, but the investigations that had been carried out were strongly in support of the view given in the paper.

Mr. Atter, commenting on what Professor Baily had said that in Scotland the County Councils had power to put the Act in force, said that the Lanarkshire and Midlothian County Councils had done that. Moreover, any person feeling aggrieved could complain to the Scottish equivalent of the Ministry of Health, which could take the matter up also. As to one large works *versus* a number of small works, the former policy had proved to be best in his own area, where there were 2000 miles of river, 2000 factories, and 400 sewage disposal works. In such circumstances the better scientific control possible in a large works had been found advantageous by comparison with the supervision, which was often left to a part-time road foreman or some such individual, of small works.

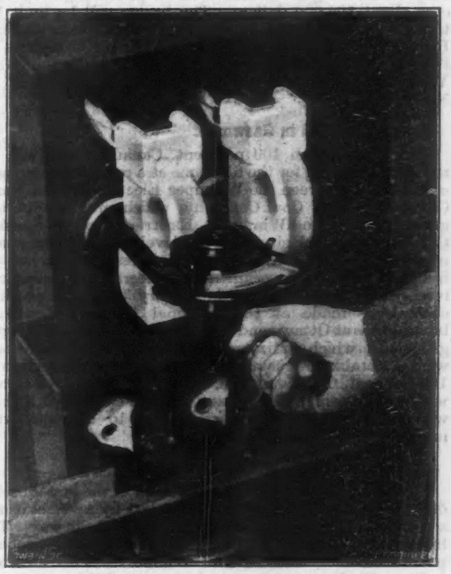
Mr. Haworth, speaking on the subject of re-used water, mentioned a case in which Parliament sanctioned a scheme by which 5 million gallons of purified sewage effluent were sent a distance of 11 miles for works purposes, thus releasing 5 million gallons of ordinary water for general use. The plant in that case was about to be put into use on account of the present dry spell. In 1929 it had also been used for a number of weeks, and by that means Sheffield had been able to spare one million gallons of ordinary water for a neighbour which was very short. The cost of the necessary plant was £450,000, and it was equivalent to installing a 5 million gallon reservoir at a very much higher cost.

Mr. Vokes, replying to the President, said the exhaust gases from the sewage gas engines was as high as stated in the paper, owing to the fact that methane gas was being burned, the speed of ignition of which was only one-tenth that of coal gas.

Mr. Watson, in a few final comments on the discussion, spoke of the progress being made in Japan, America, and Canada.

New "Tong Test" Ammeters.

Two new types of the "tong test" ammeter for measuring A.C. and D.C. without making an electrical connection have been introduced by Crompton Parkinson, Ltd., of Bush House, W.C.2. The special feature of both instruments lies in the design of the tongs, which are larger than usual. In the case of the type C instrument, shown in the accompanying illustration, the opening between the tongs is large enough to encircle porcelain fuse handles and cables up to 2½in. in diameter, and is particularly suitable for measuring current in the various circuits of unit feeder pillars. The other new instrument, designated type D, has tongs capable of embracing cables, bus-bars, or fuse carriers up to 3⅜in. diameter.



TONG TEST AMMETER

Like the original tong test ammeters, both of the new instruments are supplied with interchangeable movements, the standard ranges in the case of the instrument shown being up to 75, 100, 200, 300, and 400 ampères, and up to 100, 200, 300, and 400 ampères in the case of the D type instrument, the first scale marking in each case being one-tenth of the maximum reading. The total weight of each ammeter is 2¾ lb. If necessary, the new models can be supplied with ebonised tongs to enable them to be used on bare conductors run close together or in close proximity to earthed metal. A moulded bakelite handshield is fitted between the handle and the aluminium frame, so that when there is no risk of short circuiting adjacent conductors it is unnecessary to employ instruments with ebonised tongs. We are told that owing to error an electrician in New Zealand recently passed some 1500 ampères through a C type instrument, and although it was found impossible to open the tongs, when the instrument was subsequently tested, it was found to be absolutely accurate and undamaged.

A New Marine Oil Engine.

THE announcement is officially made that an agreement has been completed between Brooke Marine Motors, Ltd., of Adrian Works, Lowestoft, and the Associated Equipment Company, Ltd., of Southall, Middlesex, to manufacture at Brooke's Lowestoft factory a new high-speed marine oil engine for heavy fuel oil, which will be known as the Brooke-A.E.C. Diesel unit. The component parts of the new motor will be standard with those of the A.E.C. high-speed oil engine for transport vehicle work, but the design has been specially adapted to meet marine service requirements. The first of the new units, a 130 B.H.P. six-cylinder engine, is now under construction at Lowestoft. The cylinders have a bore of 115 mm. and a stroke of 142 mm., and full power is developed at a speed of 2000 r.p.m. The whole of the construction of the new engine will be carried out at Lowestoft. Primarily, the new engine will be distributed through the Brooke sales organisation, but jointly through the two firms. Messrs. Brooke will continue to supply their standard marine petrol engines and motor craft, and a full display of the firm's products, including, it is expected, the new engine, will be shown at the forthcoming Motor Exhibition, which will be held at Olympia from October 12th to 21st.

Canadian Engineering News.

(By our Canadian Correspondent.)

New Water Supply System.

For the water supply of the city of Niagara Falls, Ontario, a new intake is being constructed in the Welland River and a new 10,000,000-gallon filtration and pumping plant at Chippewa. The plant is laid out so that three additional units can be installed as needed, bringing the ultimate capacity to 40,000,000 gallons. Originally the city had an intake in the Niagara River just above the Falls, but the recession of the crest line made it necessary to abandon it some years ago. Since that time the city has been taking water from one of the conduits of a local power company.

Reservoir Completed.

The 30,000,000-gallon reservoir constructed by the city of Quebec on the Battlefields Park is now in full operation. Water was recently pumped into the second or eastern section of the dual containers for the purpose of flushing the big tank before finally filling it to its 15,000,000-gallon capacity. The western half of the reservoir was completed some time ago. This reservoir will supply water to the lower sections of the city on the north and south sides and will be a great benefit in the event of a serious fire outbreak.

Vehicular Bridge over the St. Lawrence.

Work has begun on the construction of a vehicular bridge across the St. Lawrence River. The project, which involves the planking of the New York Central Railway bridge from Cornwall, Ontario, to Nyando, New York, and the building of several miles of paved highway will cost about 300,000 dollars. The bridge will be built by the Cornwall and Northern New York International Bridge Company. The engineers and financial backers of the project are the George H. Flinn Corporation, of New York City, which built the famous Holland Tunnel at New York.

Canadian Coal in Gasworks.

Coke from 100 per cent. Canadian coal will be made in Winnipeg for the first time as a result of a contract entered into between the Winnipeg Electric Company and Crows Nest Pass Coal Company, which provides for the gasworks of the Winnipeg Electric Company using Canadian coal exclusively. This development is the result of several years of investigation and research carried on by the Federal Government engineers and industrial research staff. Extensive laboratory tests of Canadian coals were made at the National Research Council's laboratories at Ottawa and on a larger scale at the Winnipeg gas plant, which indicated that certain Canadian coals were adaptable for gas manufacture and the production of 100 per cent. Canadian coke, which would produce a coke with high heating qualities and low ash content at a price which will enable Winnipeg dealers to compete with imported coke.

First Transatlantic Steamer.

This year marks the centenary of the first crossing of the Atlantic Ocean from west to east by a vessel using, so it is stated by some authorities, steam all the way. The historic voyage was made by a Canadian-built wooden paddle steamer, the "Royal William." This steamer, built at Quebec, was launched in April, 1831, and towed to Montreal to be fitted with engines developing 200 horsepower. Her cost when ready for sea was 75,000 dollars. Her dimensions were :—Length overall, 176ft.; depth of hold, 18ft.; breadth over paddle-boxes, 44ft. She was originally intended to ply between Montreal and Nova Scotia, and the enterprise of building her was carried out by a group of Quebec and Halifax merchants, assisted by a grant of 15,000 dollars from the Government of Lower Canada. Among the shareholders appear the names of three Cunard brothers, one of whom later founded the present Cunard Line. After three moderately successful voyages in 1831 to Halifax and intermediate points she was laid up for the winter.

In the spring of 1833 a new company was formed, which purchased the vessel, and, for a time, used her for towing and local excursions. Then, in June, 1833, she sailed on a trip to Boston, where she was enthusiastically received as being the first steamship flying the Union Jack to enter a United States port. On her return to Quebec her owners decided to send her to England for sale. It was on this voyage that she made history, demonstrating to the world the feasibility of navigating the oceans by means of steam-propelled vessels, notwithstanding the declaration of critics that "they might as well talk of making a voyage from Quebec to the moon."

Early in August, 1833, she left Quebec for Pictou, in the Northumberland Strait, where she remained a few days coaling, storing, repairing engines, and awaiting passengers. Eventually, on August 17th, she steamed out of Pictou Harbour for England. Her clearance papers stated she was a vessel of 363 tons bound for London, that among the goods carried were 254 chaldrons of coal (324 tons), a consignment of ship's spars, a box of stuffed birds, one harp, one box, one trunk, household furniture and seven passengers, all British. Her master was John McDougall. During the voyage the starboard engine was disabled and the vessel sprang a leak. After twenty-five eventful days and nights the "Royal William" arrived at Gravesend. Ten days later the vessel was sold for 50,000 dollars and chartered to the Portuguese Government as a troopship.

In 1834 the ship was bought by the Spaniards, sent to Gravesend to be converted into a war steamer, and renamed the "Ysabel Segunda." Later she returned to the Spanish coast, and on May 5th, 1836, in the Bay of San Sebastian, she earned the distinction of being the first steamer of war to fire a hostile shot. In 1840 she was sent to Bordeaux for repairs, but was converted into a hulk. Her engines were transferred to a new ship of the same name, which ultimately sank off the Algerian coast during a violent storm in 1860. And so, with her hull rotting in Bordeaux Harbour and her engines lying at the bottom of the Mediterranean Sea, the "Royal William" ended her distinguished and varied career. A memorial tablet in the Canadian House of Commons commemorates the first Transatlantic voyage made by the "Royal William."

Shipbuilding and Marine Engineering.*

By A. C. HARDY, B.Sc.

This paper is mainly an extension of the ideas put forward in the author's paper of 1931 entitled "Marine Engineering as a Marketing Proposition," and deals with problems of marketing and distribution, and of salesmanship generally, with particular reference to existing conditions which are contrasted with the conditions existing in 1931, and with reference also to the problems to be faced by those firms which are coming fresh into the shipbuilding and marine engineering markets.

1933 and 1931 in Contrast.

The two years which have elapsed since the question of marine engineering and marketing was last touched on in an address before this Institute, have gone a long way to prove that by producing better and more economical "models," shipbuilders are forcing obsolescence on a great deal of existing tonnage. This, it was then suggested, would undoubtedly be the case. Unfortunately, the problem of disposing of surplus tonnage remains as prominent as it was then, although it should be remarked that there is a distinct tendency to regard with less sentiment than before the masses of old ships which continue to litter the world's harbours. If we can look to a future at all we shall find it increasingly obvious that rate of obsolescence of existing tonnage must be speeded up even more in the future. World shipbuilding may survive otherwise only as a series of government departments—into which, indeed, it may easily be in danger of transformation. The economy ships which have speeded up obsolescence have done so because of their low fuel consumption for an infinitely greater speed than was possible a few years ago, together with increase in the rapidity and efficiency with which cargo can be handled in ports. This has increased the competitive spirit among shipowners and has enlarged the field for auxiliary manufacturers. It will also result in the future in the world's goods being carried in a smaller number of faster vessels, steam or Diesel, of very high efficiency.

The number of ships per given route, therefore, must inevitably diminish in the future. Thus, world shipbuilding will decrease in quantity while increasing in quality. Assuming a return to "normal" economics of buying and selling which exists in practically no shipbuilding community to-day, returns will be better, but distribution different. A period of depression which, if existing work be a guarantee, is now slowly proceeding past its low point, has forced shipbuilders to develop economy models in order to attract shipowners so to arrange their finances that they can build them. In doing so, shipbuilders have, willy-nilly, limited quantitatively their potential output for the future. It is, therefore, only by producing more and more efficient models that they will continue to receive orders at anything like a rate consistent with their capacity. There is immediate consolation in the fact, however, that many large fleets must be reconstructed in the near future if they are to continue to give an efficient transportation service to clients. The example of the United Netherlands Company, which is gradually rebuilding the whole of its fleet, is worth remarking on. It is to be hoped that this will promote similar activities among other shipowners. For the shipbuilder, and with him the marine engineer, is faced with a battle in to-day's swirl of conflicting economic currents. He knows that the shipowner needs tonnage which, in some cases, controlling banking interests cannot, and in other cases lack of confidence in the future will not, permit him to order. The shipbuilder who is really alive knows that never before has he had more attractive propositions to offer. If he depends for his future upon the output of ships, is it not increasingly obvious that he must market his wares with greater persistency than ever before, appealing not merely to the owner, but to those people—often non-technical—who control the shipowner's policy, but who are capable of appreciating sound economics in the suggested financing of ships for entirely new trade routes ? These, as was pointed out in a previous paper, are even to-day possible, if a need for them is created.

The Shipbuilder's Point of View.

We can, with advantage, here enlarge upon the point of view of the shipbuilder. Lack of work to a shipyard means first, the discharge of skilled workmen, then, as matters get worse, the technical staffs who are behind the skilled workmen must suffer salary reductions, and later dismissal. This means that the trained staffs upon whose skill the successful production of the ship itself depends are gradually dispersed, a situation equivalent in fact to the dispersal of a well-trained football team, for the shipyard itself depends for its fine productions upon the team work of its design and drawing offices and its managerial staff. This, in general, is the position to-day in those countries whose shipyards are not given artificial life by means of Government or other subsidies. Even those yards, sooner or later, may suffer far more severely than non-subsidised yards from that species of collapse which is said to be the final condition of a patient whose strength has been maintained by drugs or some other artificial method, unless State control of industry prevails throughout the world, and if shipbuilding is to survive under normal economic conditions.

With such gloomy sentiments prevailing, surely it must seem that shipbuiders who have no hope for the future should cut their losses and close their yards; but on more mature examination it is clear that such a course would be as ridiculous as it would be unwarranted. Shipbuilding, in common with other industries, is undergoing a purifying process, and post-slump shipbuilding will bear no recognisable relationship to pre-slump shipbuilding. Not only will the post-slump shipyards be infinitely fewer, but they will be infinitely keener. They will be a virile fighting force, and they will not be controlled by boards whose feeling with regard to clients is that they (the clients) should come to the shipbuilder and ask him to build them a ship. The difference between the salesman of new ships and the salesman of life assurance policies, or of advertising space, will be merely that inherent in the commodities which each one is handling. Their vigour, persuasiveness and energy must be identical.

Postulating a slow world recovery possibly to an entirely different set of trade conditions, this recovery may be even more the age of the salesman than has been the case in the past. By that time hard economics will necessitate that boards of directors be composed of keen, hard-headed men of business whose trump cards are their international outlook, their flexibility and their ability to be in any port of the world as soon as a new contract is mooted. Such characteritics will, however, only be possible in those shipyards which have survived the slump. But the shipyards which survive, and the process of attrition is by no means terminated in this country, must be capable of tackling on an international basis contracts for all types of ships and at competitive prices. Furthermore, they must maintain a strictly impartial attitude on the ship powering question.

Contracts in future will be confined even less than hitherto to the shipyards of the country to which the owner happens to belong, and this in spite of a prevailing spirit of nationalism which bids fair to bind the wheels of commerce—a spirit which can only be kept alive by State assistance of a peculiarly blind nature. There is every indication that they will be placed on an international basis. Already, for example, there are signs that Holland is actively allying herself with Scandinavia in this connection. Such being the case, the shipbuilder of the future will have to maintain international connections. Fortunately, signs are not wanting that those British shipyards, which have all the appearances of being able to hold on until after the slump, are doing this. There is a yard on the Tyne with excellent Canadian, French, and Scandinavian connections. There is a yard on the Clyde which has built simultaneously for South Africa, for India, and for Wallasey. The shipyards of Belfast have built for Dutch, for French, for British, and for American owners. No shipyard can prosper, however, unless it keeps rigidly abreast of modern requirements. For this reason the action of British yards is to be deplored who, in search for best economy with coal fired steam plants peculiarly their own, have gone to the leading Scandinavian motor ship building yards to supply it. This is a grave indictment upon the efficiency and ability of British marine steam engineers.

The Ship of the Future.

It is interesting to speculate as to what the ship of the future may be like. In all probability the mean speed of ships will be higher. The pre slump idea was that if a cargo vessel of tramp type could make approximately 10 knots on a very high coal consumption, she was a perfectly efficient trading weapon. This is no longer true, and the higher mean speed of 12½ knots which such ships can make is partly due to the fact that extra speed can be obtained on a relatively much lower fuel consumption. The internal combustion engine, together with improvements in hull design, have made this possible, and the re-designing of the sterns of ships of single-screw type has also been of assistance, while changes in propeller design and in the outline of rudders have also been responsible for certain developments ir this connection. The internal combustion engine, using, as it does, approximately one-quarter of the amount of fuel that the old-time steam plant does, and with its ability to give increased speed with very little increased fuel consumption, has naturally recommended itself to a large number of shipowners, and in particular to Scandinavian shipowners. Apart from large passenger liner and cargo liner contracts which may be given out in the next few years, a large number of the tramp contracts are likely to be financed in connection with Scandinavian owners who are very expert in the operation and "management" of ships and who regard the map of the world not only as something which has routes emanating from British coal ports to grain ports and back. They are looking at the whole question from the point of view of countries which are likely in future to have large exports, and here the Pacific Coast of North America undoubtedly holds out a very bright future. The tramp of the future, in fact, may well be a fairly high-speed motor vessel, built and planned internationally, with a speed of 12 knots or over, and of a size and type which in pre-slump days would have been dignified by the name of a cargo liner. She may even have refrigerated space and accommodaton for the carriage of vegetable oils, and she will most certainly operate in the trans-Pacific trade if necessary. So, too, with the cargo liner in which ship type, if present trends are to be judged, speeds of anything up to 18 knots in loaded condition may be expected within the next few years.

Electricity and Auxiliaries.

Thus the shipbuilder and the marine engineer must inevitably work hand in hand. The outlook for the auxiliary maker is a much brighter one and particularly if his work is connected with electrification. Many ships to-day are electrically propelled. Others are 80 per cent. electric in the sense that all their auxiliary equipment is electrically operated. The electric ship, and, in particular, the turbo-electric ship, has introduced a new technique into the business of marine engineering, and in some cases the part played by the marine engineer is a small one. The boilers are built in one part of the country, the turbines may be built in another part, and the electrical equipment in yet a third, the two latter being under the control of one concern. As regards auxiliary gear, the winches are the work of specialist firms which have been connected with the construction of steam winches. The pumps, &c., in the power room, as well as the ventilation and forced draught fans, are electrically operated, and even though pumps and fans may be made by further sub-contractors, the motors operating them come under the constructional control of the makers of the main turbo-electric propelling machinery. Thus, a contract for a complete turbo-electric ship is a very valuable thing for an electrical manufacturing company to-day. Important auxiliaries, such as fan and pump motors, winches, control gear, &c., are in the hands of specialist firms with moderate sized organisations and reasonably low overheads. They have established names for themselves for the supply and installation of this equipment, not only in this country, but abroad. They have the entire confidence of the marine fraternity, as is instanced by the fact that whilst the whole of the electrical equipment of a recent large turbo electric liner was supplied by a leading electrical manufacturing concern in this country, certain parts of the installation were carried out by a smaller firm which has built up a reputation in the last few years for all kinds of auxiliary work.

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* Institute of Marine Engineers, September 12th.

Further development, it may be suggested, will lie in giving to the question of electric propulsion and electric ship equipment rather a new "slant." There should be, for example, in Great Britain, a future for such arrangements as dead front switchboards and for their logical placing in the ship, *i.e.*, at control platform level, and not on some almost inaccessible platform at the back of the auxiliary engine-room. Such developments, in addition to straight turbo or Diesel-electric propulsion in certain countries, also form a valuable export market. Great Britain's success during the Victorian era lay partly in the fact that she was always ahead of technical progress. To a certain extent we have "missed the boat" as far as the Diesel engine is concerned, with the brilliant exception of the activities of one or two companies in this country, and this fact is, in part, responsible for our present position in world shipbuilding; but there is no reason why we should miss the electric ship in a similar way.

Although the electrically propelled ship originated in the United States, it has now come to Europe, and on the turbo-electric side Great Britain has done more than any other country to develop it. On the Diesel-electric side, whilst France has tended to push ahead rather further than our own engineers to date, there is every indication that there will shortly be a reversal of this trend, and that Diesel electric propulsion will be adopted in a large number of ship types in this country. Already a valuable start has been made in connection with tugs and ferry boats, whilst it is certain that other vessels will be built with this type of propulsion in the near future. Is there any reason why the electric ship for those purposes for which it is suited should not become an export of British shipyards and British marine electrical concerns? Much depends on the way in which the idea is "sold," and although it would probably be absurd to suggest that complete Diesel electric tugs could be sold to Continental countries, there is no reason why electrical and Diesel equipment should not. In this connection we can cite the cases of a Diesel electric tug for the port of Antwerp and a Canadian Lake ship, in each of which the electrical gear was supplied by British firms. Apart from this, there is a large potential market overseas in the Dominions, Crown Colonies, &c.; as an example, the complete Diesel electric equipment for a new Hong Kong ferry has been fitted in a vessel in China.

There is a danger which should be pointed out here, but it is one which can be easily overcome. Where the hull is being built on one side of the world, and the propelling machinery on the other, complete liaison should be maintained between the builder and the machinery constructor to ensure that exactly the right propeller and machinery revolutions are arranged, and, above all, with high speed Diesels, that due attention is paid to seating design. Any design which the shipyard puts out in this connection should be rigorously overhauled by a competent naval architect on the staff of the machinery builders before scantlings, &c., are agreed to. Incidentally, a double liaison is required. When the electrical equipment is being built by one firm and the Diesel engines by another, and the hull by a third, the electrical manufacturer must deal with the Diesel manufacturer, and both, in turn, must deal with the hull builder. If the closest co-operation is not secured, failure may result, and the course of Diesel electric development be diverted for a number of years.

THE COMPLETE "DIESEL ELECTRICIAN."

If the firm constructing the electrical machinery were also to build their own Diesel engine, not only would all-through liaison be possible, but the electrical man would have a much better idea of the capabilities of his engine. Likewise, because all the machinery came from one organisation, the overall cost must be lower, and that is going to be one of the chief selling points as far as Diesel electric propulsion is concerned in the future. Such an arrangement would operate for the majority of orders for which quotations were invited, provided the range of Diesel engines was sufficiently flexible, not only as regards powers, but also speed and size. With the spread of Diesel electrification into an increasing number of special craft, however, particular kinds of Diesel engines would often be required, and the firm would, therefore, be called upon from time to time to go outside the range of its own engines, but they must be careful in their choice. In the past there has been far too much inclination on the part of electrical manufacturers to choose their engines carelessly. Whichever way we look at the matter, the electrical ship is bound to be the ship of the future, not necessarily with electrical propulsion, although the future here is good for certain specific types, but particularly for auxiliary equipment. To descend from the general to the particular, we may consider even such a matter as electrical steering. The shipping world must shortly adopt a really satisfactory all electrical gear, because, *inter alia*, this is more compact than an electric hydraulic gear. Many such arrangements do exist and operate with complete success, but in this country the tendency, at any rate, merely because there is not sufficient confidence, is towards the electric hydraulic gear. Then, too, there is the question of electric deck cranes, which deserves close attention. Germany and Denmark both have satisfactory types which can handle cargo effectively from the water alongside, but so far there is no British model. A special plea must be made for this, because it is a saleable article, and because it must in the future considerably augment the work of winches.

These, then, in brief, are some trends of the situation as it exists at present. It may be said in criticism of the review that few, if any, definite conclusions have been arrived at, a criticism which may be answered by saying that to day it is impossible to foretell accurately where economics may take us, and how world events may alter with natural laws. Post slump shipbuilding and marine engineering, purified and shrunken by the elimination of the weaker members, does not present a hopeless picture, but initiative on the builders' part must be one of the foremost characteristics among those who remain. Whatever be the ultimate economic trend, it would appear that some form of "salesmanship," if we interpret the term in its widest sense as liaison between builder and owner, will be necessary. For the rest we may say that if our industries are to survive as separate self-supporting units, production must be studied and controlled, and scientific marketing must be part of their programme. The continued production of more and more efficient "models" would appear to be the keystone for the development of new construction other than that of a purely replacement nature.

The Electro-Chemical Theory of Corrosion.[*]

By OLIVER P. WATTS.[†]

IT has been said of electrolysis that it splits a chemical reaction in two and permits the halves of the reaction to occur at different places. The beauty of this characterisation can be appreciated only by those who are conversant with both electrolysis and corrosion. In ordinary cases of corrosion, such as the attack of zinc or iron by sulphuric acid, the two halves of an electrolytic reaction have been put together again, and the same piece of metal serves as anode and as cathode. The most fundamental law of electrolysis still applies, viz., Faraday's law, that the total of chemical changes at the anode, where metal tends to enter solution, equals the total changes at the cathode, where elements leave the solution. The amount of hydrogen displaced from sulphuric acid by zinc is equivalent to the quantity of metal dissolved. This seems to indicate that the nature of the processes by which metal passes into solution by chemical and by electrolytic corrosion is the same.

According to the old view, attack on a metal like iron by an acid such as hydrochloric is strictly a chemical process, the greater affinity of the iron for chlorine enabling this metal to rob the acid of its chlorine, thus displacing the hydrogen.

To-day the majority of students of corrosion, and probably of chemistry also, appear to have accepted Nernst's view, that the dissolving of metals by acids or other corroding media takes place by ions (electrically charged atoms) leaving the surface of the metal. All that is needed for atoms of a metal to go into solution is that they be provided with tickets of admission, a number of positive charges equal to the valence of the metal in that particular solution. The former importance of the anion has vanished. Now it serves only for carrying current through the solution, and of itself contributes in no way to the dissolving of metal. The army of anions on reaching a soluble anode merely come to rest there and permit the metallic ions leaving the anode to pass peaceably through their ranks.

CORROSION CLASSIFIED.

Except for a single type, not often encountered, all corrosion of metals is by displacement. For simplicity and convenience, corrosion may be classified as follows:—

(1) *Corrosion without displacement of anything from the corroding solution, e.g.*, the dissolving of iron or copper by a solution of ferric chloride.

II. *Corrosion by displacement of a metal, e.g.*, the dissolving of iron by a solution of copper sulphate or of zinc in the recovery of gold from cyanide solutions.

III. *Corrosion by visible displacement of hydrogen, e.g.*, the dissolving of zinc by sulphuric acid.

IV. *Corrosion by invisible displacement of hydrogen*, following by its physical or chemical removal, *e.g.*, the corrosion of iron by sea water or of copper by dilute sulphuric acid. This is often called corrosion by oxygen depolarisation.

Type I.—This kind of corrosion occurs only when there is in the corroding solution in one of its higher valences a metal which is capable of existing in solution in at least two valences. Corrosion of this type is seldom met commercially, but is made use of in etching metallographic specimens with ferric chloride. Metal dissolves with equivalent lowering of the valence of the metal previously in the solution.

Type II.—In arranging electro-chemical series of the metals, this type of corrosion was extensively studied in the early part of the nineteenth century, although attention was then focussed on the deposition of the one, rather than on the corrosion of the other of the two metals concerned in each case. The serious consequences of confining in a tank or pipe made of an active metal a solution containing a much more inert metal, is so well known that this type of corrosion is rarely encountered. One metal replaces the other in solution. Short of actual trial, tables of potentials and of solubilities furnish the best basis for prediction in regard to this type of corrosion.

Type III.—Corrosion by visible displacement of hydrogen is possible only in those electrolytes from which the electric current deposits hydrogen, *i.e.*, water, and solutions of acids, alkalies and salts of sodium, potassium, aluminium, &c. Visible displacement of hydrogen occurs when the potential of the metal exceeds the discharge potential of hydrogen on that metal from that particular solution.

Type IV.—Corrosion by invisible displacement of hydrogen is by far the most common type of corrosion, yet is least understood. This occurs only with those metals and in those solutions in which the discharge potential of hydrogen exceeds the potential of the metal. Corrosion by invisible displacement of hydrogen proceeds as follows: When the metal is immersed in the solution it begins to dissolve, displacing its equivalent in hydrogen. This continues until the counter e.m.f. set up by hydrogen equals the thrust of the metal to go into solution, when dissolving of metal and displacement of hydrogen cease. In the case of metals whose potentials lie far below the discharge potential of hydrogen on them, the contact surfaces of metal and electrolyte must be far from saturated with hydrogen.

Oxygen from the air dissolved in the electrolyte removes hydrogen by formation of water, thus lessening the force with prevented further displacement of hydrogen, so that dissolving of metal begins again. The speed of solution of metal is limited to the rate at which oxygen reaches its surface.

PURITY *versus* CORROSION.

Will a perfectly pure metal corrode? This question has often been argued *pro* and *con*, usually with the result of leaving each of the disputants "of the same opinion still." Several authorities on corrosion disagree on this seemingly simple question, which, nevertheless, involves the fundamental principles of corrosion.

The whole argument for cessation of the corrosion of metals, if they could be obtained perfectly pure, is based on the stopping of visible displacement of hydrogen by amalgamated zinc and by certain samples of this metal of exceptional purity. No thought seems to have been given to the fact that corrosion by oxygen depolarisation still goes on—that variety of corrosion which is responsible for the major part of the annual damage by corrosion.

Advocates of the necessity for voltaic couples, points of different potential, as an antecedent to corrosion, apparently limit this claim to cases where anode and cathode consist of the same piece of metal. No one has yet claimed that there must be impurities in a metallic cathode in order that hydrogen may be displaced on it by electrolysis.

Should further experiments prove definitely that no perfectly pure metal is capable of visibly displacing hydrogen on itself from acids, which seems utterly incredible in the case of sodium, potassium, calcium, &c., nitric acid would still continue to dissolve absolutely pure zinc and copper, and corrosion of these metals in sulphuric acid by oxygen depolarisation would go on, as would corrosion by displacement of other metals and by the method of Type I. of the author's classification. Metallurgists need not worry about zinc being made so pure that it will fail to precipitate gold from cyanide solution and sacrifice itself in doing so.

THE ROLE OF OXYGEN AND OXIDISING AGENTS IN CORROSION.

It is observed that oxygen and oxidising agents stimulate corrosion of metals. Early in the history of the voltaic cell it was discovered that unless an oxidising agent was placed at the cathode, the current delivered by the cell quickly diminished through polarisation by hydrogen—*i.e.*, deposition of hydrogen on the cathode caused its potential to approach that of the zinc, thus lowering the e.m.f. of the cell. With few exceptions, the electrolytes of voltaic cells are those from which hydrogen is deposited at metallic cathodes when electrolysis occurs. To prevent this serious fall in e.m.f. during use, oxidising agents are placed at the cathode either as a constituent of electrode or electrolyte. Studies of the Leclanché cell have shown that reduction of the manganese dioxide accounts for removal of only half the hydrogen deposited at the cathode. The remainder is removed by oxygen from the air dissolved in the electrolyte. In Vol. 62 of the "Transactions" of this Society a commercial air-depolarised cell is described. Polarisation at the cathodes of primary cells has long been known, understood, and the removal of the polarising hydrogen provided for by oxidising agents, and finally by atmospheric oxygen.

About eighty years' study and experimenting in corrosion was required before this was recognised as electrochemical in character, and the function of oxygen in stimulating corrosion was not made clear for several years more. In any aqueous solution from which hydrogen is deposited on metallic cathodes, its deposition tends to displace the potential of the metal toward that of zinc. It is not necessary that there be enough hydrogen on the metal for visibility in order to cause this change in potential. It begins as soon as any e.m.f. is applied to the cell, and if the e.m.f. is gradually increased it continues until both electrode and electrolyte at the metal-electrolyte interface are saturated with hydrogen and the gas begins to escape.

When a metal is placed in a solution of sulphuric acid or sodium chloride, it begins to dissolve by the only process possible, by displacing some other element from the solution. In acids and solutions of sodium and potassium salts the substance displaced is hydrogen, the element which is deposited at cathodes from these solutions by electrolysis. In a voltaic cell without a depolariser, *e.g.*, amalgamated zinc-sulphuric acid-copper, hydrogen is visibly evolved from the copper, and no one can doubt its displacement by the dissolving of the zinc. When copper is placed in dilute sulphuric acid, it, too, starts to dissolve by displacing hydrogen, but the discharge potential of hydrogen on copper from dilute sulphuric acid exceeds the potential of copper in the same electrolyte; hence copper can continue dissolving only until hydrogen has accumulated on the metal to a concentration equivalent to the potential of copper; then there is equilibrium, and no more copper can dissolve until some of the hydrogen is removed, thereby lowering the opposition to its deposition. If air has access to the electrolyte, the oxygen slowly removes hydrogen and permits copper to dissolve at the exact rate necessary to replace the hydrogen as fast as it is removed. In the complete absence of oxygen copper does not corrode perceptibly in dilute sulphuric acid in years.

In April, 1926, the writer sealed in glass tubes in normal sulphuric acid inch-long (2·54 cm.) pieces of bright copper wire. The acid was boiled in the tube under diminished pressure and sealed under vacuum. One tube was left unsealed. The wire and liquid in this have completely disappeared, and in their place is dry copper sulphate. The acid in one tube became faintly blue after a month. Careful scrutiny showed a minute crack in the glass where sealed. Although the liquid has not evaporated enough air has diffused through the crack to cause serious corrosion of the copper. In two other tubes the acid is still water-white, and the copper is as polished as when put into the tube seven years ago.

Not only does a zinc anode displace hydrogen on the cathode of a voltaic cell when they are connected, but it displaces hydrogen on itself. In neutral electrolytes, from which the discharge potential of hydrogen on zinc and its impurities exceeds the potential of that metal, no hydrogen is seen; but in acids where the discharge potential of hydrogen is much lower, it is necessary to amalgamate the zinc to prevent continuous evolution of hydrogen on the anode and corresponding waste of zinc. Although there is now no evolution of hydrogen on open circuit, corrosion by oxygen depolarisation goes on. This corrosion of amalgamated zinc by depolarisation of the invisible film of hydrogen always present on it was recognised years ago, and the zincs were removed from the single-fluid bichromate cell when not in use, to prevent waste through oxidation of the hydrogen film by the chromic acid.

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[*] The Electrochemical Society, Chicago, September, 1933.

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Corrosion by Differential Aeration.

Corrosion by differential aeration has been much discussed. When two separate pieces of iron are placed in a neutral electrolyte and oxygen maintained at a higher concentration at one piece than at the other, the iron with the higher oxygen concentration corrodes faster and its potential is lower (more noble) than that of the other piece. When the electrodes are connected, each piece is privileged to displace hydrogen on the other as well as on itself. Enough current now flows from the metal where hydrogen is the more concentrated to raise the polarisation by hydrogen of the other electrode until their potentials are equal, except for the e.m.f. required to drive the current through the cell. The corrosion of the two electrodes should differ by an amount equivalent to the current.

Two explanations are suggested for corrosion by differential aeration. The first is that an oxide film is formed on the metal having the higher concentration of oxygen. "It is clear, therefore, that the formation of protective films on the aerated part of the metal does play a very considerable part in causing the aerated area to be cathodic."‡

"The portions to which oxygen has least ready access are those where corrosion is greatest. This conclusion may at first sight seem almost paradoxical, but the action of oxygen is of the direct chemical type, giving at the aerated portions a uniform film having some protective qualities. These parts are thus ennobled and the parts sheltered from oxygen are relatively electro-negative (more active) and dissolve by anodic attack of the ions in solution."§

The other explanation is that this is merely a case of ordinary corrosion by oxygen depolarisation, except that the two portions of the same metal which act as anode and cathode happen to be connected by wires instead of being a single piece of metal. The initial differences in potential are characteristic of metals when the hydrogen concentration at the metal-electrolyte surface is changed.

It is generally considered that the velocity of corrosion by oxygen depolarisation is controlled by the rate of diffusion of dissolved oxygen to the metal. This means that when the oxygen arrives at the metal surface hydrogen is already there, and the oxygen has a choice of uniting with hydrogen or metal. That an oxide should be formed in the presence of hydrogen, and later be reduced by hydrogen, seems an entirely unjustifiable, not to say unreasonable, assumption. Granting that an oxide is formed, it should, like the copper oxide cathode of the Edison primary cell, prevent accumulation of hydrogen, and so promote continued flow of current. Dr. Blum makes the revolutionary suggestion that no hydrogen is displaced by metals dissolving by oxygen depolarisation, but that "cathodic reduction of oxygen can be considered an electron reaction, which is much more likely to occur than the frequently assumed process of hydrogen evolution and subsequent reduction of oxygen by hydrogen."

Electrolytic Protection.

In electrolytic protection the metal is made cathode and loaded up with hydrogen by an external e.m.f., so that there shall be no point on which the metal can itself push out hydrogen. In the Gunderson process plating with arsenic insures that there shall be no corrosion of the steel by visible displacement of hydrogen, for the discharge potential of hydrogen on arsenic, even from acids, exceeds the potential of iron.

Residual Current and Corrosion.

Residual current is that microscopic current which flows in an electrolytic cell at any voltage below the e.m.f. of decomposition without visible products of electrolysis. It is the current equivalent of the rate of depolarisation of the electrodes by the electrolyte. At a constant voltage the current diminishes with time, but never ceases. It has been studied both with platinum electrodes and an e.m.f. external to the cell, and with electrodes of different metals, in which case the cell supplies its own e.m.f.

Corrosion of type IV. is the same phenomenon, except that here a single piece of metal serves both as anode and cathode; but the corrosion is controlled by the rate of removal of hydrogen by dissolved oxygen, just as both current and corrosion in the experiment cited are fixed by the rate of depolarisation of the cathode. A thorough study of residual currents under various conditions should throw much light on corrosion of type IV.

A Film of Hydrogen.

Metals, when placed in acids or solutions of sodium salts, must displace on themselves a concentration of hydrogen equal to their own potentials, else there would be no acceleration of corrosion by oxygen depolarisation. Copper, silver and other inert metals which are incapable of visibly displacing hydrogen from dilute sulphuric acid, corrode very slowly when allowed to stand in the acid.

It is only at the potential of copper in sulphuric acid, for example, that there can be equilibrium between copper and hydrogen; at any potential more noble than this, if copper began to deposit on a cathode, it must re-dissolve with displacement of hydrogen until equilibrium is reached. So very minute currents of the order of magnitude of residual currents deposit hydrogen, not copper, from air-saturated solutions of copper sulphate.

In the early days of the study of corrosion the mistake was made of attributing the stopping of corrosion by the film of hydrogen to its insulating power, and in some quarters this erroneous opinion is still held. It is the polarisation (counter e.m.f.) produced by it, not its resistance, that reduces corrosion and the current in voltaic cells. In one case the residual current between nickel and iron was found to be 1/20,000 of the current density usually used in chromium plating, where a storm of hydrogen is evolved at 6 to 8 volts. The resistance of the films of hydrogen encountered in corrosion are negligible.

Nernst's Osmotic Pressure and Helmholtz's Electrolytic Double Layer.

"According to the well-known classical theory of Nernst, each metal has a definite solution pressure, which is a measure of the tendency of the metal to pass into aqueous solution in the form of ions. This solution pressure is opposed by the osmotic pressure of the metal ions, which tends to drive them out of solution, depositing them on the metal. With the reactive metals, such as zinc, the solution pressure is greater than the osmotic pressure, positively charged zinc ions go into solution, and the metal acquires a negative charge. When the solution pressure is less than the osmotic pressure, as in the case of copper and the 'nobler' metals in solutions of their salts, ions of the metal are deposited, giving a positive charge to the electrode, whilst the solution in the vicinity is negatively charged by the corresponding anions. The surface of the electrode is thus the seat of an electric double layer."[3]

The solution pressure of zinc is stated to be $9{\cdot}9 \times 10^{18}$ atmospheres, or five million billion tons per square inch, and that of copper $4{\cdot}8 \times 10^{-20}$, a quantity unimaginably small.

"In accordance with Nernst's assumption, when a bar of zinc is placed in water, zinc atoms each give up two electrons to the bar of metal and pass into the water as positively charged ions. In this way an electric double layer is formed at the junction of the metal and liquid. That but an exceedingly minute quantity of zinc enters the water in the form of ions, notwithstanding its enormous electrolytic solution pressure, is due to the electrostatic attraction of the negative charges which accumulate on the bar of metal. Evidently the relative values of the osmotic pressure and the electrolytic pressure determines whether ions leave or enter solution."[4]

Helmholtz's double layer is a myth. Not only is it stated above that metal ions pass into solution without displacing their equivalent in other positively charged ions, but the very existence of a double layer depends on their doing so. If metals dissolve by displacing on themselves, or another conductor in electrical contact with them, their equivalent in positively charged ions, there can be no accumulation of electric charges on either metal or electrolyte! Experience shows that, except for type I., all corrosion of metals is by displacement.

Nernst's conception of the "osmotic pressure" of the ions of the metal already in solution as equalising or even overcoming solution pressure, chemical affinity, or whatever name is applied to the force which causes metals to dissolve, is also untrue. A sheet of copper, 48 square cm. in area, immersed for twelve days in 250 cc. of normal copper sulphate lost 0·1386 g. in weight! According to Nernst, as quoted above, copper tends to deposit from solutions of its salts.

How can osmotic pressure and an electrolytic double layer be reconciled with this corrosion of copper in a strong solution of copper sulphate by oxygen depolarisation? Yet modern texts on physical and electrochemistry continue to present Nernst's theory of osmotic pressure and Helmholtz's double layer as "law and gospel," to be swallowed by embryo scientists, greatly to the impairment of their scientific digestions! These figments of the imagination were created to explain the practical stopping of corrosion of the anode in certain primary cells when the circuit is opened, and the fact that metals of high potential fail to dissolve quickly and completely when placed in neutral electrolytes. Now that it is known that their supposed job of limiting corrosion is performed by hydrogen, and that they were never capable of doing it in the first place, they should be plainly labelled as scientific conceptions that have outlived their usefulness.

After thirty years, Whitney's statement that corrosion is electro-chemical in nature still stands as our best definition of the electro-chemical theory of corrosion.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

GRAPHICAL SYMBOLS.

No. 108—1933. A British Standard List of Graphical Symbols for Electrical Purposes was issued in 1922, and at about the same time the International Electrotechnical Commission started to interest itself in the question of symbols. The British National Committee (*i.e.*, the Electrical Industry Committee of the British Standards Institution) participated in this international undertaking, and in the course of the preparatory work, a number of suggestions were noted for consideration when the B.S. Symbols came up for revision. The International Electrotechnical Commission published its report on Symbols in 1930, and the revision of the B.S. Symbols was then considered in detail, with the result that B.S. No. 108—1933 has just been issued. The revision of the previous edition has been thorough, and although no changes have been made merely for the sake of a change, the internationally agreed symbols have been substituted in a large number of cases. In other cases the international symbols are in conformity with current British practice so that no change has been necessary.

The new list of symbols is fuller than the old list, but a note in the Introduction makes it clear that still further additions will, no doubt, be called for as the applications of electricity develop.

An important new feature is the introduction of a letter code, the object of which is to reduce the number of graphical symbols that would otherwise be necessary. The code letters, which are devised on a mnemonic basis, are, in certain cases, embodied in the graphical symbol itself, but in the majority of cases they are intended to be written alongside the graphical symbol. In either position, however, the code letters provide a ready means whereby a tabulated index of symbols used on any diagram may be indicated on each drawing. A comprehensive wiring diagram, embodying as many as possible of the graphical symbols, is included in B.S. 108—1933, as an example of the application of the letter code.

BRITISH STANDARD CAST IRON MANHOLE COVERS AND FRAMES.

No. 497—1933. The British Standard Specification for Cast Iron Light Manhole Covers and Frames, No. 497, has recently been issued by the British Standards Institution. The covers and frames dealt with are intended for domestic purposes and not designed to carry traffic loads. A specification for heavier covers for this purpose is being contemplated. The present specification deals with quality of material, dimensions, weights, galvanising coating, soundness and inspection by the purchaser. The standard sizes provide for interchangeability and replacement of broken covers without the trouble and expense of removing existing frames.

ROAD MOTORS FOR THE L.M.S.

The L.M.S. Railway Company announces that orders have been placed with British motor manufacturers for 166 new road motor vehicles and for the reconditioning of twenty-five chassis. These orders, which comprise the company's programme of new road motor vehicles for the current year, embrace all types of motor vehicles, including heavy lorry chassis, liverstock carriers, light parcel vans and "mechanical horse" tractors. An important feature is the placing of orders for a further seven vehicles of a special type for augmenting the services recently inaugurated by the L.M.S. in agricultural areas for the transport of livestock.

Details of the various orders are as follows:—

Albion Motors, Ltd.—Nine LK 50 5-ton chassis, with Gardner 4 L.W. engines; one LJ 27 4-ton petrol engine chassis; five LC 43 2-ton petrol engine chassis. These vehicles will be fitted with cabs and bodies in the L.M.S. carriage and wagon department works.

Leyland Motors, Ltd.—Five Leyland Beaver 6-ton chassis with Leyland compression ignition engines, forward control type with cabs. Bodies to be fitted in L.M.S. works.

Karrier Motors, Ltd.—Six CY 3 2-ton chassis to be fitted with parcels van bodies in L.M.S. works

Associated Equipment Company, Ltd—Six Mercury 4-ton chassis, with compression ignition engines; cabs and bodies to be fitted in L.M.S. works; Seventeen A.E.C. Y type chassis to be reconditioned and fitted with Gardner 4 L.W. engines, C.A.V. lighting sets and pneumatic tires; cabs and bodies being fitted in L.M.S. works.

Ford Motor Company.—Twelve Fordson BB 2-ton chassis, 157in. wheelbase, bodies fitted in L.M.S. works; thirty Fordson BB 2-ton chassis, 131½in. wheelbase, bodies fitted in L.M.S. works; four Ford 1-ton chassis; one Fordson hand-operated tipping lorry, 157in. wheelbase; three Ford 14·9 H.P. Tudor saloon cars; one Ford 14·9 H.P. Fordor saloon car.

Morris Commercial Cars, Ltd.—Thirty-eight Morris C 13 type chassis, bodies to be fitted in L.M.S. works; one Morris station omnibus.

Miles, Ltd., Cheltenham.—One Fordson Sussex chassis, with Miles livestock carrying body; one Fordson chassis, with Biflex articulated trailers, one trailer with Miles livestock body and one trailer with flat lorry body.

S.M.T. Company (Alexander Motors), Edinburgh.—Five Fordson Flexion chassis, with livestock carrying bodies.

Jowett Cars, Ltd.—Twelve 10-cwt. light vans.

Scammell Lorries, Ltd.—Six Scammell "Mechanical Horse" tractors.

Cranes (Dereham), Ltd.—Eighteen trailers for "Mechanical Horse" tractors.

Fleet Motors, Birmingham.—One Fleet three-wheeled light delivery van.

J. I. Thornycroft and Co., Ltd.—Eight Thornycroft JC type 10-ton six-wheeled tipping lorries, to be reconditioned and fitted with Gardner compression ignition engines.

CONTRACTS.

Charles Hill and Sons, Ltd., Bristol, have received from the Severn and Canal Carrying Company, Ltd., of Bristol, an order for a vessel to be fitted with a 120 B.H.P. Kromhout engine. It is to be a duplicate of the "Severn Trader," also built by Charles Hill and Sons.

Brooke Marine Motors, Ltd., Lowestoft, have received from the Lobitos Oilfields, Ltd., an order for the urgent construction of a motor tug for shipment to Peru. The vessel will be 45ft. long with a beam of 11ft., and will be used chiefly for the purpose of mooring up the large oil tanks at the end of a pipe line. The engine will develop 80 H.P. at 800 r.p.m.

International Combustion, Ltd., has secured an order from the Rand Water Board, South Africa, to supply and erect two C.S.G. Tri-drum boilers for the Zwartkopjes pumping station, each unit evaporating 70,000 lb. of water per hour at a pressure of 180 lb. per square inch and superheated to 680 deg. Fah. These boilers will be fired by Underfeed "L" type forced draught stokers, and be fitted with Green's gilled tube economisers and M.L.S. superheaters.

The Atlas Diesel Company, Ltd., has received an order from W. T. Lamb and Sons, Ltd., Shoe-lane, E.C.4, for a "British Polar" Diesel engine, type K 35 M, developing 725 B.H.P. at 250 r.p.m. This will be direct-coupled to an Asea 500 kW, 400-volt, three-phase alternator, and will be used for supplying power and light to a new brickworks at Bletchley. Another recent order comprises four 450 B.H.P. engines for driving generators on a new vessel building at Harland and Wolff's yard at Belfast, for the Shaw, Savill and Albion Company, Ltd.

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‡ Evans' "Corrosion of Metals," p. 93.

§ Hedges' "Protective Films on Metals," p. 47.

[3] Hedges' "Protective Films on Metals," p. 12 (1932).

[4] Creighton and Fink's "Electrochemistry," 1, p. 172 (1924).

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Current Business.

Several fair-sized contracts have been reported lately, but most of them have been for work in this country, and there is still a scarcity of important overseas business for which British firms may tender. It is reported that the Pearson and Knowles Engineering Company, Ltd., of Warrington, has taken a contract which is said to be valued at £200,000 for the construction of a Bessemer steel plant for the new works of Stewarts and Lloyds, Ltd., at Corby. Sir William Arrol and Co., Ltd., of Glasgow, have secured a contract in connection with the extension scheme of the Scottish Dyes factory at Grangemouth, the value of which is placed at £20,000. The Scottish Dyes Factory is controlled by Imperial Chemical Industries, Ltd. The Department of Overseas Trade announces that the following contracts are open for tender :—South African Railways and Harbours : 288 tons mild steel rivets of various shapes and sizes, to be presented in South Africa by October 16th ; one 15-ton electrically driven portal Titan crane for Port Elizabeth Harbour ; also for the supply of pig iron of approved brands, to be presented in Johannesburg by October 23rd ; about 2414 tons of mild steel to specification C.M.E. 9/1930 in squares, flats, rounds, hexagon section, angles, &c., to be presented in Johannesburg by October 9th. Australia, Electricity Commission of Victoria : Supply of galvanised soft iron and steel wire ; steel strand and wire rope required during the twelve months from the date of acceptance of the tender, which must be presented in Australia by November 25th. Posts and Telegraphs Department : Submarine telephone cable, to be presented in Melbourne by November 14th. Brazil, Rio Grande do Sul State Railways : Sixteen metallic superstructures for new viaducts, including four steel spans of 26 m. and twelve of 25·4 m., to be presented in Brazil by October 13th. City of Belem, Para : Water purification plant, to be presented in Belem by October 14th.

Pig Iron.

The pig iron department continues to be one of the most active sections of the British iron and steel markets. The position on the North-East Coast is particularly satisfactory, as the stocks of Cleveland iron in the producers' hands have been reduced to small proportions, and consumption, for the time being, is larger than production. It is expected that an additional furnace will shortly be blown in, and it is also reported that the furnace which Dorman Long and Co., Ltd., intend to start soon on the production of basic iron for their steel works will later on be turned over to foundry iron. An active business has been transacted with the Scottish light foundries, which are paying the fixed price of 65s. 3d. d/d Glasgow, and 62s. 3d. d/d Falkirk for Cleveland No. 3 iron. Recently, more export business has been done at cut figures, and some fair sized transactions have taken place with Danish buyers. The Midland makers are also finding a steady demand from the light castings makers in that district. Stocks in the makers' hands remain heavy, but the demand seems slightly above production and a gradual decrease in these accumulations is expected. Many of the larger buyers have covered their requirements for some weeks ahead, but the general demand, although it consists chiefly of small orders, amounts in the aggregate to a considerable tonnage. Rather quieter conditions have ruled in the Yorkshire iron market, as many of the Sheffield consumers have arranged their supplies for some time ahead. In Lancashire the demand sharply improved at the beginning of September, and since then the rate of consumption seems to have been well maintained. Some of the engineering concerns have bought fair quantities and there is a better tone in this branch of the industry. Perhaps the worst feature of the situation in Lancashire is the poor demand for textile machinery, which, of course, reacts upon the call for pig iron. Staffordshire, Midland, and North-East Coast brands of foundry iron are quoted at 67s. for No. 3, whilst Northamptonshire foundry is quoted at 1s. 6d. less. Business in the Scottish iron market has been quiet, but there is a fair demand from the foundries, although the local producers are meeting with competition from Indian and English iron.

Semi-finished Steel.

Active conditions continue to rule in the market for semi-finished steel, and the British works producing this class of material are busily engaged. Competition from the Continent is rarely heard of, and although it was known that the Continental Cartel had released a few thousand tons for the British market recently, the movements of the exchange made the selling price too high to be attractive to consumers in this country, and counter bids were not accepted by the Continental works. Business, therefore, was confined to a few odd lots which were required by users who were prepared to pay a high price for Thomas steel for special purposes. The British makers hold their quotations at £5 for billets, 500 ton lots and over, and £5 7s. 6d. for lots of 100 tons or less ; but these are the minimum prices, and in some cases premiums are asked, particularly for tested billets. Lately there has been a better demand for higher carbon material, which ranges from £5 12s. 6d. to £6 12s. 6d. British sheet bars are quoted at £4 15s., although here, again, in some districts works have asked up to £5. In Wales, however, where efforts have been made lately to sell Continental material, the local works have kept to their official figure of £4 15s. d/d for sheet bars and tinplate bars. There is no doubt that some consumers are watching the market in the expectation that if the sterling exchange improves, Continental makers will be in a position to compete for British business. On the other hand, the home makers are confident that the Continent will not sell large quantities at the poor prices they are obliged to take. Considerable resentment is felt by British merchants at the action of the Continental Cartel in doing all its British business in semi-finished steel through the works' selling organisations and refusing to allow the merchants to participate.

Finished Steel Materials.

Business in finished steel materials has been somewhat irregular of late, and whilst in some districts active conditions prevail at the mills, in others orders are being worked off more quickly than new business is coming to hand. Competition in the home market from Continental steel was practically non-existent last week, as the low sterling exchange made the price of Continental material practically the same as that of British steel when the duty was taken into account. Midland makers complain that orders, although increasing in number, are still for the most part confined to small tonnages. The price of Continental steel bars, delivered Birmingham, was £6 14s. 6d., and as the British re-rollers were prepared to take £6 15s. no transactions in Continental steel were reported. Early this week, on the movement of the exchange, the Continental quotation dropped about 4s. 6d.; but this attracted little business. The works in this district are all busy on strip, for which a demand exists which it is difficult to satisfy. On the North-East Coast the position of the various works is more satisfactory than for many years past. A fair amount of railway work is still in hand, and it is expected that the production of this class of material will be increased. The worst feature in this district is the poor demand for shipbuilding steel, as orders for new ships are still scarce. Some of the ship repairers, however, are rather busy, and their requirements provide welcome work for the steel mills. The sheet works on the North-East Coast are well occupied and the flow of orders from the structural steel works is on a good scale. In South Wales the tin-plate industry, which has been experiencing a rather light demand for some weeks, has improved its position lately, the order for oil sizes for the Near East, referred to last week, having provided fresh work for a number of the mills.

Scotland, Lancashire, and Yorkshire.

There is a good deal of unemployed plant in Scotland, but the industry is working under more cheerful conditions than at any time during the past few years. The demand for shipbuilding steel has improved of late, although the shipbuilding contracts placed recently have not been of importance. The works producing railway material are busy, and if the tube makers are not so well employed as they were a month or two back, they still have work to carry them on for some weeks, and there are prospects of new business coming to hand. The sheet works also are busy, and about 3000 tons of the Argentine order for sheets referred to last week has been placed with F. Braby and Sons, Ltd., and Smith and McLean, Ltd. As this order has to be completed by the end of October, the works are already busily engaged upon it. Lancashire steel makers complain that few important contracts have come their way of late, and this policy of buying in small tonnages necessitates frequent changes of the rolls, and adds to the overhead charges. Some of the structural engineers have bought rather more freely of late, but the demand from this branch of the trade leaves room for considerable expansion. Locomotive builders in Lancashire are not well off for work, and as a consequence the demand for boiler plates is limited. Business in special alloy steels, however, has been maintained, and there has been an improvement in the business in bright bars. In Yorkshire the steel markets are steady without any outstanding feature. The Sheffield rolling mills are working at a high rate, whilst the tool steel makers are busy. There has also been some increase in the demand for alloy steels, although the call for magnet steel has declined.

Finished Iron.

There is more activity in this section of the market than is customary at this time of the year, particularly in the Midlands. Some useful inquiries are reported to have been circulated, and now the holidays are over it is anticipated that the requirements of the railways and wagon builders will be on a fair scale. This is the more probable as this industry has received little support from the railways, which are normally its best customers. Prices are unaltered, marked bars being £12, with Crown bars at £8 10s. to £9 10s. The Lancashire works report only a quiet demand for iron bars, but there has been no alteration in prices in this market, the quotation being for Lancashire best bars £9 10s. and for Crown bars £9. There has not been much pressure on the Scottish bar iron rollers and most of the business reported of late has been in horseshoe iron. A certain amount of business has also been done in iron strip for the manufacture of gas pipes. The minimum price quoted for Scottish Crown quality bars is £9 15s. d/d Glasgow, whilst for export the price is £9 5s. f.o.b. The position with regard to this material, however, is similar in all districts, and although there are encouraging signs in the market the demand will have to greatly improve before the situation at the works can be described as satisfactory.

Ferro-alloys.

The position in this market has become somewhat confused owing to the movements of the exchange. Business is difficult and the tendency for trading to expand has been checked, as buyers have adopted a cautious policy, and have declined to enter into commitments excepting at fixed prices. The position of sellers is equally uncertain, since the fluctuations of the exchange have made it difficult for them to quote firm prices or to arrange forward contracts over a period. A certain amount of business, however, has been transacted in small parcels for prompt delivery. The demand for ferro-chrome has been moderately good, but in one or two cases low-carbon grade material has been sold at cheap prices. Quotations received from abroad for the higher carbon grades have been at advanced rates, as the figures were based on gold quotations. As a result, little business has resulted. Somewhat similar conditions have ruled in the market for ferro-silicon, and although no change has been made in the quotation for home delivery, export business has been almost impossible to arrange. The demand for tungsten remains poor, but, on the other hand, holders are not pressing sales and, in some cases, supplies have been divided amongst consumers. This is owing to the difficulty of obtaining supplies of ore, as the Chinese are still restricting the quantities they offer and are declining to renew contracts which have expired. On previous occasions Chinese sellers have endeavoured to squeeze the market. Fresh sources of supply are being sought in Peru, Portugal, and, to some extent, in Cornwall.

Copper.

The position in the electrolytic copper market does not improve, and consumers in Europe and America are probably still awaiting the result of the "Code" experiment before committing themselves to forward purchases. A few weeks ago sufficient copper was bought to enable consumers in the United States to carry on well into the autumn without making fresh purchases, whilst in this country and on the Continent, although stocks are low, users are not busy, and are well able to await events. It is certain that the possibility of a fall in the price of copper if the American experiment does not succeed is present in the minds of most users of the metal. The American producers have held their official price at 9 c. d/d, but this figure has been shaded by second hands. On this side of the Atlantic the producers have done their best to increase the demand by making cheap offers to the manufacturers of finished copper materials, without achieving much success, although the sterling price has slipped back to £39 c.i.f. One of the features of the position is that little attention is now paid to the dollar price, as the American market is of lessening importance to this country, supplies of copper from the Empire and other sources being sufficient to meet requirements. As a consequence, the sterling quotation at times seems to have little relation to the American price. Anticipations are rife that the statistics for August will show a substantial reduction in the American stocks, and this, of course, should have a sentimental effect upon the world position.

Tin.

After showing some weakness, the tin market became firmer at the beginning of this week. For the time being the market seems to have lost confidence, but probably this is merely the effect of the decline in American buying, which for some time past has been confined to spasmodic movements and latterly has practically ceased. Another reason for the easier tendency in the market was the suspicion entertained in some quarters that the tin production quota will be increased before the end of this year. Other authorities, however, cannot believe that the Tin Control will make any change in the quota before next January, and this view has become the more generally accepted one. It is thought that a good deal of the tin recently offered on the market, and which has had something to do with the recession in prices, was metal released by the Pool. Tin is still being taken out of Liverpool warehouse in considerable quantities for shipment to the United States ; but another conflicting factor in the position is that second-hand sales have been made in America on a substantial scale. This indicates that some of the tin which it was claimed some weeks ago was going into consumption in the United States was really metal purchased by investors who expected to see an advance in the price, and who are now returning it to the market. This will naturally have a damping effect upon speculation. Although it is early days to forecast the September statistics, it is anticipated that they will show a further decrease in the visible supply.

Lead and Spelter.

The lead market has been featureless for the past week or two, and prices have shown a tendency to recede. The demand from the consuming trades, particularly those supplying the building industry, has been fairly good. In fact, a short time ago a number of unusually heavy contracts were placed with the manufacturers of lead products, against which they immediately bought their supplies of raw metal, so that unless a fresh demand develops from the building and associated trades, there is not likely to be a great deal of buying from this source. Other consuming industries are responsible for a steady demand. On the other hand, the production of lead is in excess of requirements, and although of late there has been no attempt to press sales, the producers have not held back supplies. At present levels, however, the price is regarded as low, and any revival in buying would be likely to have an immediate effect upon values. . . . Steady conditions have ruled in the spelter market this week, and prices have fluctuated within narrow limits. The situation in this market is regarded as being particularly sound, as it is generally understood that stocks in Europe are declining and that consumption, particularly on the Continent, is on the increase. The American statistics for August also were satisfactory, inasmuch as they showed a reduction in the stocks of 8900 tons, bringing the total to 100,247 tons, which is the lowest figure recorded since May, 1930. More speculative interest has been taken in the market, and there is a bull account open which the holders show little inclination to liquidate. A considerable tonnage of September spelter was declared on the market, but was quickly absorbed. One of the disappointing features of this market is still the poor demand from the galvanisers. There has been an improvement in business in galvanised sheets, and it is hoped this may result in more buying from that industry.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	£ s. d.	£ s. d.
N.E. Coast—		
Hematite Mixed Nos.	2 19 0	2 19 0
No. 1	2 19 6	2 19 6
Cleveland— *(D/d Tees-side Area.)*		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
Midlands—		
Staffs.— *(Delivered to Black Country Station.)*		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—

N.W. Coast—

Hematite Mixed Nos.
3 15 6 d/d Glasgow
4 0 6 „ Sheffield
4 5 6 „ Birmingham

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL *(continued)*

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G to 13-G., f.o.r.	8 10 0	8 10 0
14-G to 20-G., d/d.	9 15 0	8 15 0
21-G. to 24-G., d/d.	10 0 0	9 0 0
25-G. to 27-G., d/d.	10 12 6	9 12 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 10 0
2-ton to 4-ton lots	12 17 6
Under 2 tons	14 10 0

Export; £16 7s. 6d., c.i.f. duty paid India.
„ £11 0s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel ports, 16/9 to 17/–
Tin-plate bars, d/d South Wales works, £4 15s.

Billets.	£ s. d.
Basic Soft (25·41% C.)	5 15 0
„ Medium (0·42% to 0·60% C.)	6 12 6
„ Hard (0·61% to 0·85% C.)	7 2 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 25% C.), 500 tons and up	5 0 0
100 tons	5 7 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

		Per Ton.	Per Unit.
Tungsten Metal Powder		2/– per lb.	
Ferro Tungsten		1/9 per lb.	
Ferro Chrome,	4 p.c. to 6 p.c. carbon	£21 17 6	7/–
„ „	6 p.c. to 8 p.c.	£19 7 6	7/–
„ „	8 p.c. to 10 p.c.	£18 17 6	7/–
„ „	Specially Refined		
„ „	Max. 2 p.c. carbon	£29 15 0	9/–
„ „	„ 1 p.c. carbon	£30 17 6	10/–
„ „	„ 0·70 p.c. carbon	£35 15 0	12/6
„ „	„ carbon free	10d. per lb.	
Metallic Chromium		2/8 per lb.	
Ferro Manganese (per ton)		£10 15 0 home	
„ Silicon 45 p.c. to 50 p.c.		£12 10 0 scale 5/– p.u.	
„ „ 75 p.c.		£18 2 6 scale 6/– p.u.	
„ Vanadium		12/8 per lb.	
„ Molybdenum		5/6 per lb.	
„ Titanium (carbon free)		9d. per lb.	
Nickel (per ton)		£225 to £230	
Ferro Cobalt		5/6 per lb.	

NON-FERROUS METALS.

Official Prices, September 13th.

Copper—		
Cash	£35 10 0 to £35 11 3	
Three months	£35 13 9 to £35 15 0	
Electrolytic	£38 10 0 to £39 10 0	
Best Selected Ingots, d/d Birmingham	£39 5 0	
Sheets, Hot Rolled	£66 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
Brass—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9¼d.	9¼d.
„ Brazed	11¼d.	11¼d.
Tin—		
Cash	£216 0 0 to £216 5 0	
Three months	£216 2 6 to £216 5 0	
Lead:	£11 15 0 to £12 3 9	
Spelter:	£16 16 3 to £17 1 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 12/9
„ Glasgow— Ell	13/6 to 13/9
„ „ Splint	14/6 to 14/9
Ayrshire—	
(f.o.b. Ports)—Steam	11/3 to 11/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/3 to 12/6
Unscreened Navigation	12/– to 12/6
Lothians—	
(f.o.b. Leith)—Hartley Prime	11/– to 11/6
Secondary Steam	10/9 to 11/–

ENGLAND.

Yorkshire—		
Steams		17/– to 19/6
Gas Coke		16/6 to 24/–
Northumberland—		
Best Steams		13/6 to 14/6
Second Steams		12/6 to 13/–
Steam Smalls		8/6
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/6
Foundry Coke		16/6 to 17/6
Sheffield—	Inland.	
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	8/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	19/6
Second Smokeless Large	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	19/– to 36/–
Furnace Coke	15/– to 17/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Breaker Duff Rubbly Culm	8/6 to 11/–
Steam Coals:	
Large	18/– to 20/6
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.

Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	3¾d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Confidence and Trade.

THE industrial activity that accompanied the collapse of the franc seven years ago, when everyone spent their money on manufactured goods of tangible value, was an instance of what may follow temporarily on loss of confidence in a nation's currency, but any permanent activity can only come from confidence, which feeling it is now sought to stimulate on the ground of rising prices. Notwithstanding the publication of official index figures purporting to show a decline in the cost of living there is visible evidence of an increase in prices, which is one direct result of an exaggerated system of import restrictions that eliminate competition on the home market and create a scarcity of certain commodities. This again combines with taxation and charges to inflate production costs, particularly in relation to costs prevailing in some countries with depreciated currencies. The possibility of a continued inflation is being made use of to organise propaganda designed to encourage consumers to "Buy now." If such a movement can be accelerated, it is hoped that it will create confidence amongst consumers who will continue to buy on a rising market. This should benefit the engineering trades, in which there has lately been a more confident tone, and it is probable that they would respond readily to any success of these efforts to encourage the expenditure of money.

The Navy.

The recent death of Monsieur Georges Leygues recalls the part he played in reconstituting the Navy which had been left by the war totally inadequate for the country's needs. He presented his programme of construction in 1920, with the proviso that it should be carried through as it stood, without modifications that would impair the homogeneous character of the new fleet. The danger of successive Ministers of Marine imposing their own ideas had been revealed before the war, when the French Navy had become what was commonly called a "collection of samples." The determination with which Monsieur Leygues carried through his plan did not make things easy for the Conseil Supérieur de la Marine and the Commission de la Marine in the Chamber of Deputies, when it became evident that the development of the German Navy could only be countered by the construction of battleships. The Minister insisted on the light cruisers being put on the stocks this year, despite the advice of the Commission that, for reasons of economy, they should be held over in view of the expenditure on the "Dunkerque." Since the programme was put in hand, 291,500 tons of ships have been built. Monsieur Leygues also aimed at increasing the efficiency of the Navy by remodelling the system of training, building the new naval college at Brest, replacing the old cruiser used as a training ship with a specially built "Jeanne d'Arc" which can navigate all seas, and sending ships on commission to colonial and foreign ports. He also retained for the Navy control over its special branch of aviation, at a time when it was proposed to concentrate the entire organisation in the Ministry of Air. The late Monsieur Leygues is succeeded as Minister of Marine by Monsieur Albert Sarraut, the former Colonial Minister.

Energy from Warm Water.

The Claude-Boucherot system of utilising the difference between surface and deep-water temperatures in tropical seas for the production of energy having failed to pass beyond the experimental stage, Monsieur Georges Claude has communicated his plans to the Académie des Sciences for testing the system on a small scale by means of a plant to be installed on a cargo ship of 10,000 tons, which is now being fitted out by the Chantiers de France at Dunkirk. It is expected that the equipment will be completed in about ten months' time. The ship will be anchored off a tropical coast, where it is hoped to demonstrate the possibility of producing ice cheaply in sufficient quantities by this system to modify the conditions of existence in the tropics.

Level Crossings.

The suppression of level crossings is again being advocated, as the result of collisions between motor cars and trains, which are becoming more frequent with the growth of road traffic. It was decided some years ago to suppress these crossings, and this has been done in the more dangerous cases, but the cost of carrying roads above or below railways is so considerable that the work is hampered by want of funds. The railway companies declared that it could only be done with money provided for the execution of the national programme of public works, but as the necessary funds have not been voted the suppression of level crossings has made little progress. The companies are doing their best to ensure safety by means of long distance caution signals, with danger signals that indicate automatically the closing of gates. Many systems are being tried. A method of signalling that depends upon the closing of gates is not always reliable, as was shown again last week when two collisions between motor cars and trains, involving the loss of several lives, were caused by failure to close gates. The problem has become a serious one with the extraordinary development that is taking place in road traffic.

A Big Dredger.

The entrances to most French ports in the Channel need constant dredging, and the work of deepening them for ships of increased draughts necessitates the use of dredgers of larger capacity, one of which, launched last week from the Chantiers de France at Dunkirk, is declared to be the biggest yet built. This dredger, the "Pas de Calais II.," has a length between perpendiculars of 69 m., and is equipped with two engines, each of 1040 H.P. For dredging one of the engines is disconnected from a propeller shaft to drive the chain buckets. The dredger is capable of raising 600 cubic metres of spoil an hour.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

396,457. February 10th, 1932.—LINKS FOR TRAVELLING CHAIN-GRATE STOKERS, Brian Mundell Thornton, of Winnington Hall, Northwich, Chester; and Imperial Chemical Industries, Ltd., of Imperial Chemical House, Millbank, London, S.W.1.

Links or grate bars for travelling chain-grate stokers are designed, in accordance with this invention, so that they can be easily replaced without involving the shutting down of the furnace and dismantling of the grate or even the stoppage of the grate. The side surface of the link is recessed or inset at A adjacent to the slot B, the hook C swinging freely on a small projecting pivot D. The dotted outline G of the hook shows it in the open position, prior to insertion of the link into position over the pivotal support E. Upon insertion, however, the pivotal support takes up the position shown and the hook is swung into the position C, thereby closing the open end of the slot and locking the link into position.—*August 10th*, 1933.

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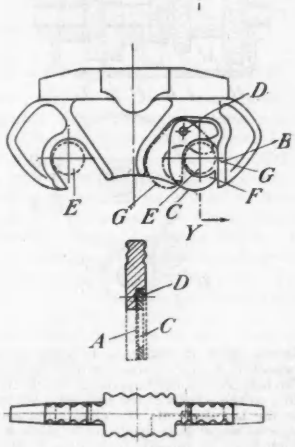

396,489. March 19th, 1932.—SCRUBBERS FOR USE IN THE TREATMENT OF GASES, London Power Company, Ltd., and Standen Leonard Pearce, both of Ergon House, Horseferry-road, London, S.W.1.

A scrubber built in accordance with this invention for use with a process for cleaning or purifying flue or other gases consists of an outer casing A and superposed rows or layers of boards B or plates of wood, metal or other suitable material, the layers of plates or boards running horizontally across the tank, chamber or tower A. The boards or plates of the respective layers are parallel to one another and arranged at an inclination to the horizontal, those in one row, for example, sloping downwards towards the left, while those in the next adjacent row slope downwards towards the right, and so on throughout the whole series of rows or layers. Each board or plate is provided at its upper edge with a strip or fillet C which may be secured upon the face of the plate, as shown in Fig. 1, or upon the end thereof, as shown in Fig. 3, and which is disposed substantially at right angles to the plate or board. The outer upper edge of the latter or the outer lower edge of the fillet is rounded and the lower edges of the boards of one layer are so disposed relative to the fillets of the next lower layer that the liquid from a higher layer is caught by the fillet and is conducted to the underside of the board or plate of the lower layer. The boards or plates of each layer are spaced apart so that the upper edge of one board or plate slightly overlaps the lower edge of the adjacent board or plate. The layers or rows may also themselves be somewhat spaced apart, the arrangement being such that while very intimate contact between the gas and the treating liquid can be obtained there will be no undue resistance to the passage of the gas through the scrubber. When the plates or boards show a tendency to sag or warp in such a manner as to collect the flow of washing medium to a greater extent at one part of the board than at others a substantially even flow of washing medium over the whole length of each board or plate may be ensured by providing the lower edge with a serrated or similar formation D, as shown in Fig. 4. Fig. 2 shows a series of scrubber plates formed of metal in which the fillet at the upper edge of each board is formed as a flange by bending the metal plate.—*August 10th*, 1933.

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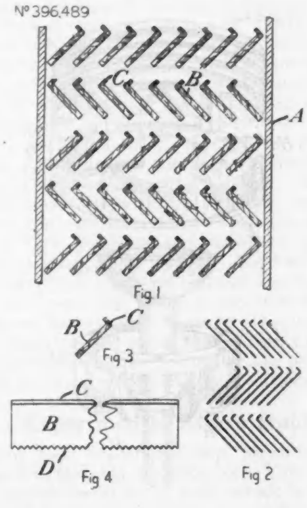

DYNAMOS AND MOTORS.

396,075. January 28th, 1932.—DYNAMOS FOR MOTOR VEHICLES, Joseph Lucas, Ltd., of Great King-street, Birmingham; Oliver Lucas and Ernest Owen Turner, both of the same address.

When a dynamo is employed on a motor vehicle for charging a battery which supplies current to an engine starting motor ignition system, lamps and other electrical accessories, the dynamo is ordinarily of the self-exciting type. Before the dynamo comes into action it is necessary that its speed shall have reached a predetermined lower limit. At and above that speed the dynamo is connected to the battery, and remains so connected, under the control of an automatic switch, until the dynamo speed falls below that at which the switch automatically re-opens. Modern developments in the electrical equipment of motor vehicles, such as the introduction of mechanisms whereby the engine is automatically re-started in the event of unintentional stoppage, or the controlling of the disconnection of the starting motor from the engine by conditions dependent on energy supplied by the dynamo, have led to difficulties with dynamos of normal construction, owing to the fact that the dynamo must attain a considerable speed before it can be relied upon to supply the required energy. The object of the present invention is to obviate these difficulties.

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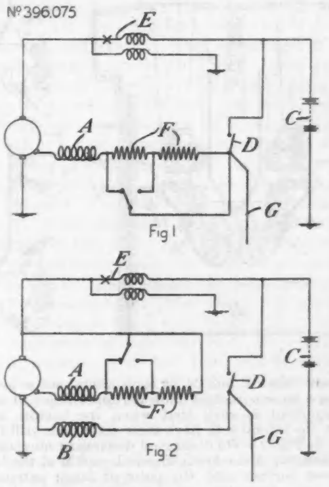

In carrying the invention into effect, as shown in Fig. 1, the normal field winding A is employed for excitation. Alternatively, as shown in Fig. 2, an additional winding B may be employed. The connection of the field winding with the battery C is effected by a hand-operated switch D. After the switch has been closed the dynamo begins to generate immediately the engine is started, and the voltage produced is approximately proportional to the dynamo speed until it reaches that of the battery. Thereafter the dynamo is caused to operate normally with self-excitation through the closing of the automatic switch E. If the engine speed falls below the speed at which the dynamo generates the battery voltage, the switch E re-opens and separate excitation is resumed. When the engine stops the switch D is opened. It will be noticed that the switch D is connected at one end to a position between the automatic switch E and the battery so that current can flow to the dynamo field winding independently of the condition of the switch E. In Fig. 1 the resistances F in series with the field winding are the ordinary resistances used to control the field winding and form no part of the invention. In Fig. 2 these resistances are shown in the normal field winding circuit which is separate from that controlled by the switch D. If desired, the same switch D may also be used to control a circuit connected with the ignition apparatus as indicated by the line G.—*July 28th*, 1933.

396,259. December 23rd, 1932.—ALTERNATING ELECTRIC CURRENT MOTORS, Edgar Wall Dorey, of Avenue Chambers, Vernon-place, Southampton-row, London, W.C.1.

The object of this invention is to provide improved arrangements for controlling the phase of the current traversing the windings of induction motors with a view to promoting starting and effecting an improvement in the power factor of the load constituted by the motor. The usual stator winding of a single-phase induction motor is indicated at A, the stator being also provided with an auxiliary winding B connected in series with a condenser C. The winding B is preferably arranged in slots in the magnetic core of the motor in the same manner as the usual starting winding, and during starting the terminals D E of the auxiliary circuit constituted by the winding B and the condenser C in series with one another are arranged to be connected to the terminals of the main winding A, as shown in Fig. 1. The auxiliary winding B then operates as a starting winding, the current traversing this winding having a leading phase relative to the current traversing the main winding A. It will be evident that the voltage impressed upon the terminals D and E cannot exceed the voltage impressed upon the winding A, and by connecting these terminals to intermediate points in the winding A the voltage across the terminals of the auxiliary circuit and thus the voltage across the terminals of the winding B and across the condenser C can be determined as desired. As soon as the motor has attained its normal or a predetermined speed the terminals D E of the auxiliary circuit are disconnected from the winding A and connected together, as shown in Fig. 2, so that the auxiliary

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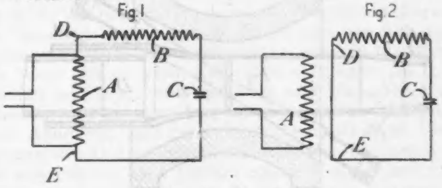

winding B and the condenser C are included in a closed circuit. Under these conditions the auxiliary circuit operates to improve the power factor of the load constituted by the winding A, and since the voltage impressed upon the terminals of the condenser C is positively determined by the electromotive force induced in the auxiliary winding B by the current traversing the winding A, this voltage can by suitably designing the winding B be arranged to correspond to the terminal voltage of a standard type of condenser.—*August 3rd*, 1933.

SWITCHGEAR.

396,488. March 19th, 1932.—HEAVY DUTY CIRCUIT BREAKERS, Herbert Astbury, of Coval-avenue, Chelmsford, Essex; and Crompton Parkinson, Ltd., of Netherfield Works, Guiseley, near Leeds.

The operation of the circuit breaker constructed in accordance with this invention is described as follows:—Assume the circuit breaker is closed, as shown in Fig. 1, and that by reason of overload it is released to open. The moving insulator A commences to move downwardly and carries down with it the pivots of the bell crank levers B C and D E. Under the action of their springs F and G these rock and carry the lower ends of their depending arms away from one another. This results in the separation of the main parts of the bottom pair of contact fingers and causes contact of the extensions J and K thereof, which roll on one another and finally separate. During this movement the contact finger L and M of each lateral set is lowered and at the same time is rocked upon its upper finger O and P, but the arrangement is such that when the bottom set is fully separated the lateral sets have their extensions still in contact, as shown in Fig. 2. On continued downward movement of the moving insulator A the lower fingers L and M of the lateral sets are lowered further and the pairs of finger extensions rock further upon one another and finally separate, forming two further breaks in the circuit in series with the first break, as shown in Fig. 3. The movement is such that the first bottom contacts open with great rapidity. Owing to the high pressure generated between the first contacts on opening under heavy fault conditions, the effect of an oil blast is obtained by displacing oil within the tank towards the lateral pairs of contacts.—*August 10th*, 1933.

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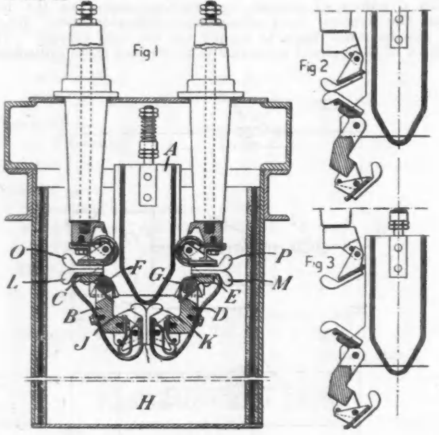

MACHINE TOOLS AND SHOP APPLIANCES.

396,669. May 2nd, 1933.—PRODUCING AN END THICKENING IN TUBULAR BODIES MADE BY ROLLING WITH SKEW ROLLS, Heinrich Esser, of Hagelkreuzstrasse 37, Hilden, Rhineland, Germany.

Although the forming of a thickening of the wall at the end of tubes is of great importance for the connection of the tubes with one another, it cannot be effected conveniently by the tube-manufacturing methods usually employed. According to the invention the hollow body A coming from the piercing rolls passes, as it travels to the reducing skew rolls, a press or a hammer (not shown), where, by upsetting it at the end or forging it in a die, the constriction B, Fig. 1, is produced. As the hollow body leaves the piercing rolls at a sufficiently high temperature and the operation of drawing it in can be carried out in a few seconds, there is no serious loss of heat and the hollow body can be passed directly after being forged to the skew rolls. In the rolls C the withdrawn mandrel D is pushed into the blank, until the mandrel head E bears against the constriction B. On the mandrel D being pushed further forward, the hollow body is pushed between the rolls until the blank is seized by the rolls F, Fig. 1. The constriction B will then bear against the forward end of the mandrel and is reduced by the rolls without the mandrel being forced forward to the external finished diameter of the tube, the thickening G, Fig. 2, being thus produced. The mandrel then moves forward into the final rolling position, Fig. 2, the part H adjoining the thickening G gradually widening, corresponding to the forward motion of the mandrel, to the internal diameter of the finished tube.—*August 10th*, 1933.

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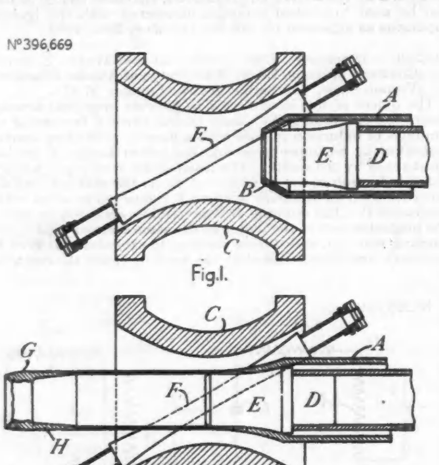

MOTOR CARS AND ROAD TRAFFIC.

396,493. April 4th, 1932.—CHANGE-SPEED GEARS, Zahnradfabrik Friedrichshafen Aktiengesellschaft, of Friedrichshafen, Lake Constance, Germany.

This invention relates to change-speed gears for motor vehicles of the type having a driving shaft, a driven shaft, a lay shaft, and a second lay or reversing shaft carrying an idler wheel for reverse gear, all the toothed wheels being of the helical type and the displaceable wheels being carried by the helically splined driven shaft. The object of the invention is to construct a relatively simple four or a greater even number of forward speeds and reverse gear of the above kind. The driving shaft A and the driven shaft B are coaxial. On the former there is the wheel C and the driven shaft B, which is helically grooved, carries the sliding wheels E, F, and G necessary for obtaining the forward speeds. The helically toothed opposing wheels H, J, K, and L corresponding to the wheels of the two main shafts are fixed in common on the lay shaft M. To enable the reversing to be effected a special wheel N is fixed on the shaft B, the inclined teeth of which have an opposite inclination to the teeth of the other wheels on the shaft B and to the course of the helical grooves of the shaft B. A double width sliding wheel O, arranged on the reversing shaft P, can be brought into gear with this wheel N, and in its turn the wheel O is in constant mesh with the wheel L on the lay shaft M.—*August 10th*, 1933.

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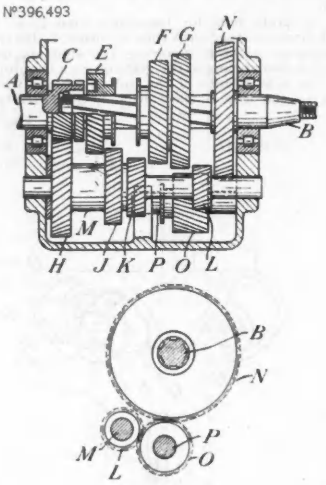

MISCELLANEOUS.

396,407. February 2nd, 1932.—UNIVERSAL JOINTS, Christopher George Nevatt, of "The Haven," Waterford-road, Henleaze, Bristol; and Ernest George Kingston, Secretary of the Bristol Tramways and Carriage Company, Ltd., of Clare-street House, Bristol.

The object of this invention is to construct a universal joint with light parts offering a large surface to take pressure and giving equal expansion when heated. The piston A is hollow with one end closed. It has six internal radial ribs B, which reach to the closed end and constitute the sole connection between the main body of the piston and a skirt C. Apertures are left between each adjacent pair of ribs. The piston is open at the end at which the skirt is located and inside the piston, supported by the ribs B, there is an annular flange D, which carries a cup E of spherical contour with its convex face directed towards the open end of the piston. The cup lies wholly within the interior of the piston and the ribs B extend down its concave face to support it, the flange D being substantially radial with respect to the cup. The connecting-rod F has a cup G at one end with a concave face. The cup is of spherical shape, the concave face corresponding in curvature to the convex surface of the cup E. The flange D is perforated at H to permit a retaining cap J to be bolted to it, the apertures in the piston between the ribs B permitting of access to the bolts for tightening. The retaining cap J is divided diametrically into two parts so as to permit it to be readily placed in position, and it has a spherically shaped concave surface K corresponding in curvature to the convex face of the cup G. When the cap J is bolted in position in conjunction with the cup E it constitutes a housing in which the cup G is a close fit with freedom to slide to take up a variety of angular settings.—*September 30th*, 1932.

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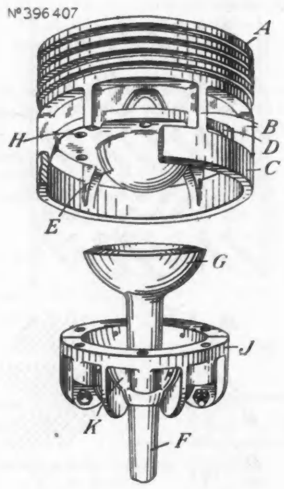


Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

IRON AND STEEL INSTITUTE.—Autumn meeting at Sheffield. For programme of papers to be discussed see page 169.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Some Suggested Improvements in London Train Services," Mr. H. A. Vallance. 7.30 p.m.

TO-DAY TO WEDNESDAY, SEPTEMBER 20TH.

ALUMINIUM CONFERENCE AND EXHIBITION.—Curio House, Hamburg. Sessions, Thursday, September 14th, 10 a.m.; Friday, visit to Hamburg Experimental Tank, 9.30 a.m.; Saturday, visit to Rhenania Ossag Works, Harburg, 9 a.m. Embark on East African Line s.s. "Njassa" for Heligoland, 1.30 p.m.

TO-DAY TO SATURDAY, SEPTEMBER 23RD.

SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.—Olympia, London, W. Daily, 11 a.m. to 9 p.m.

MONDAY TO THURSDAY, SEPTEMBER 18TH TO SEPTEMBER 21ST.

INSTITUTE OF METALS.—Autumn Meeting in Birmingham. For provisional programme see page 98.

WEDNESDAY, SEPTEMBER 27TH.

INSTITUTION OF WELDING ENGINEERS: NORTH-WESTERN BRANCH.—Manchester College of Technology, Manchester. "Experiences by Practical Welders." Speakers, Messrs. W. Bellingham, W. W. Ely, C. Peat, and E. W. Hart. 7.30 p.m.

SATURDAY, SEPTEMBER 30TH.

MANCHESTER ASSOC. OF ENGINEERS.—Visit to works of Henry Simon, Ltd., Cheadle Heath. 2.15 p.m.

TUESDAY, OCTOBER 3RD.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Elmbank-crescent, Glasgow. Presidential Address, Professor J. D. Cormack.

WEDNESDAY TO SATURDAY, OCTOBER 4TH TO OCTOBER 14TH.

INSTITUTE OF PATENTEES.—Central Hall, Westminster, S.W.1. Ninth International Exhibition of Inventions. Daily.

THURSDAY, OCTOBER 5TH.

STEPHENSON LOCOMOTIVE SOCIETY.—No. 1, Dining Club, King's Cross Station, N.1. "The Railways of South Wales," Mr. D. S. Barrie. 6.30 p.m.

FRIDAY, OCTOBER 6TH.

INSTITUTION OF SANITARY ENGINEERS.—Caxton House (Hill's Restaurant), Tothill-street, Westminster, S.W.1. Opening sessional meeting. Reception, 7.30 p.m.; music and dancing, 8 p.m. until 11.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Education with Particular Reference to the Engineer," Mr. K. W. Willans. 7.30 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Permanent Way," Mr. W. A. Willox. 7.30 p.m.

THURSDAY, OCTOBER 12TH.

ROYAL AERONAUTICAL SOCIETY.—At Royal Society of Arts, John-street, Adelphi, W.C.2. "Air Traffic Control," Major R. H. S. Mealing. 6.30 p.m.

FRIDAY, OCTOBER 13TH.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Grosvenor Restaurant, Glasgow. "James Watt" dinner.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Influence of Harmonics in Transformer Circuits," Mr. E. Ambrose. 7.30 p.m.

FRIDAY, OCTOBER 20TH.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. Annual general meeting. Address by the President, Mr. R. J. Walker; cinematograph film, "Mechanism of Ships' Wake," Professor T. B. Abell.

SATURDAY, OCTOBER 28TH.

STEPHENSON LOCOMOTIVE SOCIETY.—Visit to Stratford, L.N.E. Railway Running Sheds. 2.30 p.m.

LAUNCHES AND TRIAL TRIPS.

SOUTHERN CROSS, motor yacht; built by Cammell, Laird and Co., Ltd., to the order of the Melanesian Mission Trust (England), Ltd.; dimensions, 120ft. by 28ft. 6in. by 12ft. 6in. Oil engines, Gardner type; launch, September 4th.

BARON ELGIN, steel screw steamer; built by David and William Henderson and Co., Ltd., to the order of Messrs. H. Hogarth and Sons, Glasgow; dimensions, 365ft. by 51ft. 6in. by 26ft.; to carry cargo. Engines, triple-expansion, 21½in., 37in., 62in., by 42in. stroke; pressure 210 lb. per square inch; constructed by the builders; launch, September 6th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. J. T. H. LEGGE has been appointed managing director of Edmundsons Electricity Corporation, Ltd., as from September 1st, 1933. Mr. A. N. Rye, formerly managing director, who has been associated with Messrs. Edmundsons for many years, has retired.

GILBERT GILKES AND GORDON, Ltd., Kendal, England, have taken over the water-power connection of Messrs. W. Gunther and Sons, the partners having decided for private reasons to retire from business. Under this arrangement Messrs. Gunther's drawings, data, patterns, &c., have been removed from Oldham to Kendal.

MR. A. P. M. FLEMING, director and manager of the research department of the Metropolitan-Vickers Electrical Company, Ltd., has been reappointed local Honorary Secretary for Great Britain of the American Institution of Electrical Engineers, for the two-year term beginning August 1st, 1933. Particulars and forms of application for the various grades of the A.I.E.E. can be obtained from him.

THE DRAYTON REGULATOR AND INSTRUMENT COMPANY, Ltd., West Drayton, Middlesex, England, has acquired the exclusive manufacturing licence for the British Empire for instruments manufactured by Union Apparatebau m.b.H. Karlsruhe i.B. These instruments comprise a range of indicators and recorders for very light pressures, simple and differential; volume, density and heat value.

A Seven-Day Journal

Hire-Purchase.

It was announced a few days ago that in nearly forty cities and towns in Great Britain an important and far-reaching plan for the control and development of hire-purchase trading is to be put into operation almost immediately. In consequence of a considerable speeding up of preliminary inquiries and other matters of routine, long and medium-term credit will be more quickly available to approved purchasers. The new plan, which has been evolved by the mutual trade protection movement throughout Great Britain, in co-operation with Bankers Commercial Security, delegates to local trade protection societies the approval of credit risks and the receipt of payments. The scheme has been adopted by the International Association for the Promotion and Protection of Trade in London and other centres, and many of the mutual provincial societies affiliated to the National Association of Trade Protection Societies. This Association, which is nearly a century old, has a membership of 40,000 manufacturers, wholesalers and retailers. All phases of distribution and its financing are provided for in the plan. The manufacturer, whose relations are with the retailer or directly with the user, and the wholesaler operating either nationally or in prescribed areas, will, it is stated, have the advantage of a national credit machine covering practically every important trading centre. Such a system, in addition to operating much more quickly than a remote central office, will allow each transaction to be judged in the light of local knowledge and conditions. The retailer, in dealing with long-term credit sales, will refer the customary preliminary inquiries to the local trade protection society, on whose recommendation the sale will be financed. Afterwards, the society will receive the payments as they become due.

A New Telephone Cable.

On Monday, September 18th, the work of laying a new telephone cable between St. Margaret's Bay, Kent, and Calais, was completed, and from the beginning of November telephoning across the Channel will be greatly facilitated. It is said, in fact, that it will be possible to put through calls to Paris in little more than a minute. A new repeater station at St. Margaret's Bay will strengthen the calls of English subscribers who will be able to speak through their own instruments to over nine-tenths of the world's telephone users. The amplifying apparatus has already been installed in the station, which will be ready for service in about six weeks. Only one attendant will be necessary to supervise the working of the station. The number of lines from Calais to the Kent coast has been increased from forty to sixty, and with the extension of the "on demand" service across the Channel, Paris will be telephonically as near London as Birmingham. While shortly after the war England had telephone communication with only two countries—France and Belgium—at the present time practically every country in the world is connected with London.

Gift to Sheffield University.

In connection with the meeting of the Iron and Steel Institute at Sheffield last week and the presidency of his friend Mr. W. R. Lysaght, Sir Robert Hadfield announced his intention of presenting a gift of £5000 to the University of Sheffield, in order to commemorate the visit of the Institute in 1905 when he was President. The gift will be formally received at the next meeting of the University Council, and it is understood that Sir Robert's wish that the money be spent on the advancement of metallurgical knowledge will be honoured. This is not the first time that Sir Robert Hadfield has benefited the Sheffield community, for we recall his previous generous gifts to Firth College, the research laboratory of the Applied Science Department, the Cutlers' Company, and other local bodies. It is well known that Sir Robert has expressed warm approval of the suggestions recently made by Dr. J. H. Andrew, the Professor of Metallurgy at Sheffield University, with regard to the establishment of a course for foundry workers within the Faculty of Metallurgy, which he referred to in his letter to the Vice-Chancellor of the University. The money given by Sir Robert may possibly form a nucleus of a fund for this special purpose.

Oil from Coal.

The Industrial Development Council of South Wales and Monmouthshire considered on Monday the details of the scheme prepared by the Sub-committee of three, consisting of Professor George Knox, Dr. Roy Illingworth, and Mr. H. H. Merrett, for the production of oil from coal. The scheme, which met with considerable criticism and was even described by one of the authors of the memorandum as a highly speculative proposition, is to be further reported upon, the Sub-committee being given plenary powers to select as many additional members as may be considered advisable, representing all interests. That enlarged committee is to report to a future meeting of the Council. The memorandum states that assuming one hydrogenation plant and ten 1000-ton L.T.C. plants are distributed along the south-eastern outcrop of the coalfield, the total cost may be estimated at £7,000,000. The hydrogenation plant would produce 100,000 tons of petrol per annum, using about 365,000 tons of coal, and find permanent employment for 1000 miners and 1500 process workers. Its construction would also give temporary employment to about 15,000 men for a period of one year. Ten 1000 L.T.C. plants would treat 3,650,000 tons of coal per annum, producing about 240,000 tons of heavy oil, 40,000 tons of light oil, 70,000 tons of pitch, 3,220,000,000 cubic feet of surplus gas, and 2,520,000 tons of smokeless fuel. These plants would find permanent employment for 4000 miners and 1400 process workers and temporary work for 12,000 men for one year. The combined plants would therefore use over 4,000,000 tons of coal annually and produce about 1,500,000 tons of liquid and gaseous fuel and 2,500,000 tons of smokeless fuel. An alternative scheme would be to limit the hydrogenation process to the oils produced from the L.T.C. plants, together with what could be obtained from gasworks, coke ovens, &c. This scheme would cut down the initial capital expenditure by about £2,000,000, and produce a more profitable yield, as the tar oils worth £2 10s. per ton would be converted into petrol worth £15 per ton.

Finance for Small Firms.

"British industry is now experiencing a severe reaction against the wholesale rationalisation which was recently looked upon as a universal panacea," said Mr. Stanley Townsend, secretary, British Data Service, to the Dartford Rotary Club on Tuesday. It was worthy of note, he said, that in America, the smaller firms had on the whole weathered the storm more successfully than the large units. Improved standards of management in the small and medium-sized firms had reduced the advantages of mere size as such. But more adequate facilities for obtaining finance were urgently required for the small and medium-sized firms, which were at a great disadvantage in approaching the public as compared with the large company and yet frequently offered better security to the investor. Many small firms were to-day starved for more capital, which they required for such purposes as financing mechanisation and widening their sales. At the same time, the investor was showing a greater interest in the small firm, which was under the continuous control of a full-time board, in preference to companies controlled by directors whose presence was, to say the least, intermittent. "In my view," added Mr. Townsend, "a duty rests upon the City of bringing into effective relationship the investors who want to put their money in the sound small firms, and the small firms which are in need of further capital. There is room for a new type of investment trust designed to fulfil these purposes."

The Use of Mechanical Power.

Speaking at a luncheon at Birmingham on Thursday last, September 14th, on the subject of "Power," Mr. Walter F. Higgs, of Higgs Motors, Ltd., Witton, expressed some doubt as to whether mankind had attained to any greater happiness by the introduction during the past 150 years of mechanical power in its various aspects. It had come, he said, and it was going to stay, because it was man's natural function to wrest from Nature her mysteries, but it was discovery and not the ultimate result of discovery that really caused satisfaction to man. Amongst the things which it had brought in its train were the rapid transport of thought and matter, added ease and comfort, perhaps, certainly undesirable artificial light, bad housing conditions through the industrial revolution, noise, deaths through mechanical accidents, and the great slaughter of war. All these things had come about during the last 150 years. What about the next 150 years ? From the engineering point of view, Mr. Higgs said, he believed we were at the lowest rung of the ladder. We had been in possession of a tool which we had not known how to use, and the next 150 years would afford us the opportunity of learning how to use it. Our inventions would be along the line of improving man's lot. We would house people better, distribute the population better, and the land would be better cultivated.

An Experimental Ship's Hold.

On Friday last, September 15th, an official visit was arranged to the Ditton Laboratory, East Malling, where an experimental ship's hold, which is used for the study of biological engineering problems connected with the grading and packing of apples and their behaviour under conditions of sea transport, was inspected. The hold is now being prepared and filled with apples for the coming season's work, a process which usually occupies about two weeks. This year's experiments are being made with a special kind of wooden case employed in the Australian fruit trade, with the object of studying the shape of the case and its relation to air distribution between the cases, and the effect on the maintenance of a uniform temperature within the hold space. The experimental hold, inside the insulated walls, measures 34½ft. by 30½ft. by 15ft., has a capacity of nearly 16,000 cubic feet, and can take a "cargo" of approximately 130 tons, or 7000 bushel boxes, of apples when fully loaded. It can be refrigerated either by means of brine pipes inside the hold or by circulating air by means of fans over an external cooler and back again through the cargo. These methods on a ship, corresponding respectively to the grid system and the battery system of refrigeration, are capable, however, of a number of modifications which can be tested in turn in the experimental hold. Over 200 thermometers are used to obtain temperature readings, many of them distant recording instruments, so that readings may be taken over definite periods corresponding to a ship's watches, and the results plotted in curve form. Investigations are also made on the shape of intermediate air spaces and the design of the small laths or battens, termed dunnage, which are placed between the individual boxes. A study of the problem has suggested that a few large channels for air circulation would be considerably more efficient than a number of small crevices. The inspection was made under the guidance of Dr. A. J. Smith, who is carrying out the work under the auspices of the Department of Scientific and Industrial Research.

The Future of Coal.

In the course of an address on coal, delivered at the Sir John Cass Technical Institute on Monday last, Mr. Frank Hodges stated that features of the British coal trade which, for years past, had been hoped to be transient and fleeting, had come to be regarded as permanent and static. The shrinkage of output and *personnel* as between 1913 and 1932, revealing a decline in tons of output of 78,000,000 and a decline of persons employed of 340,000, was sufficient proof of the permanent contraction of the industry. He regarded 1930 as perhaps a representative year for the next decade, with an annual output of approximately 240,000,000 tons and the number of employed at about 900,000. The question on which the industry should concentrate was how to restore that 1930 level at remunerative prices, so that funds would again be available for further technical developments and wages and profits. The importance of technical efficiency could not be exaggerated. Electricity and gas would, he thought, continue their inevitable march, but coal was their fundamental raw material. Foreign oil was coal's real enemy, and the one which should be attacked over the next decade with the utmost technical and scientific vigour. He urged a mass research attack on the whole problem of scientific coal utilisation. That, he suggested, was a surer road to travel than the apparently unfruitful way of re-establishing British coal in world markets.

The Fireproofing of Timber.

In connection with a visit made by members of the British Association on Wednesday, September 13th, to the Market Bosworth works of the Timber Fireproofing Company, Ltd., Mr. J. H. Narbeth gave an account of the present position with regard to the fireproofing of timber and particularly mentioned the progress made with the Oxylene process. A demonstration of the fire-resisting qualities of Oxylene-treated wood and a new fire-resisting fabric termed Boram was made. In the course of his remarks, Mr. Narbeth dealt with the testing of the fire-resisting qualities of wood and fibrous materials and the use of an ignition test value obtained by igniting the gas from a wood specimen, also the open and the closed burning tests. Mr. Narbeth gave figures for various kinds of untreated wood, which showed that fir was slightly superior to mahogany and oak and slightly inferior to red pine, while Oregon pine competed with teak for the superior position. For teak the typical results obtained were, in degrees Centigrade:—Flash point of the gas from the wood, 250 deg.; closed combustion point, 290 deg.; and open combustion point, 470 deg. Reference was made to the use of Oxylene-treated wood by the Admiralty and the Royal Air Force and on large liners, and to the work done by the Marine Department of the Board of Trade, the British Standards Institution, and the Fire Officers Committee.

The Late Sir Alexander Glegg.

By the death of Sir Alexander Glegg, which took place at his home, Princes-road, Wimbledon Park, on Tuesday, at the age of eighty-five, we lose an eminent engineer and business man, who, in his later life, was closely identified with the civic life of London and with wide religious and philanthropic interests. Alexander Glegg was born at Stonehaven, near Aberdeen, and received his education at the Gymnasium, Old Aberdeen, and Aberdeen University. He was trained as a marine engineer and came to London, where he spent some time in the drawing-office at Woolwich Arsenal. On leaving Woolwich he played some part in the designing and perfecting of the Hoe-Webb printing press. Later he became proprietor of Bowen and Co., Ltd., brassfounders, and did pioneer work in introducing to this country cast aluminium cooking vessels. He was a director of the Linoleum Manufacturing Company, Ltd., and later its chairman. He was also chairman of Barry and Staines Linoleum, Ltd., and a director of Barry, Ostlere and Shepherd, Ltd., and John I. Thornycroft and Co., Ltd. For some time he held the chairmanship of the Linoleum Manufacturers' Association.

The Shipping, Engineering and Machinery Exhibition at Olympia.

No. III.

(Continued from page 253, September 15th.)

B. J. HALL AND CO., LTD.

THE exhibit of B. J. Hall and Co., Ltd., of Stourton House, Dacre-street, London, S.W.1, provides clear evidence of the great advance which has been made in recent years in the design and production of engineering drawing-office equipment and material. The exhibits on the stand have been chosen as far as possible to illustrate the efforts made by Mr. B. J. Hall and his staff to help the designer and inventor to express their ideas easily and happily. In 1896 Mr. Hall invented the electric copier, and turned from civil engineering to devote his energies to further drawing-office improvements.

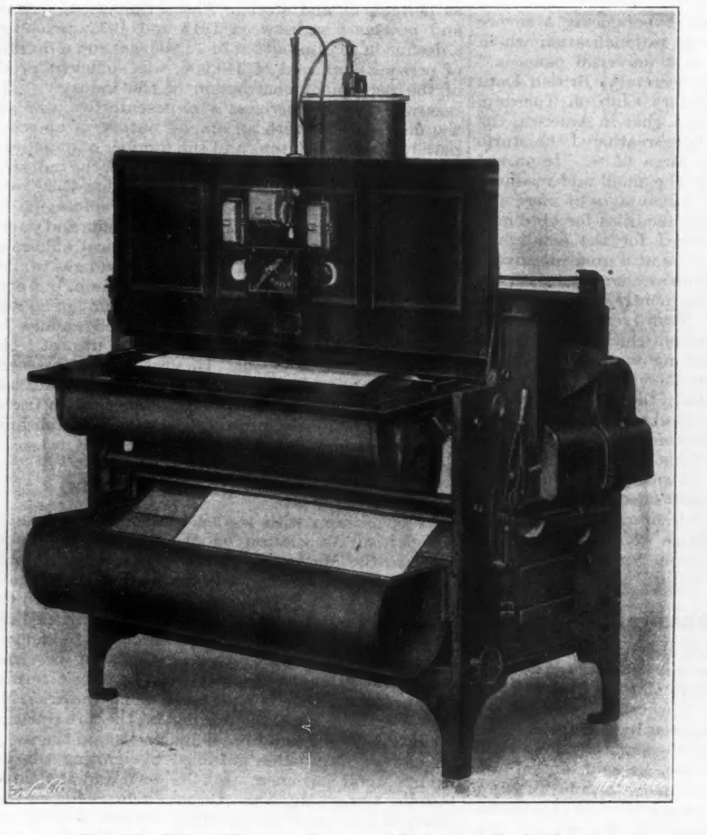


FIG. 53—"HALL-MARK" COPYING MACHINE—B. J. HALL

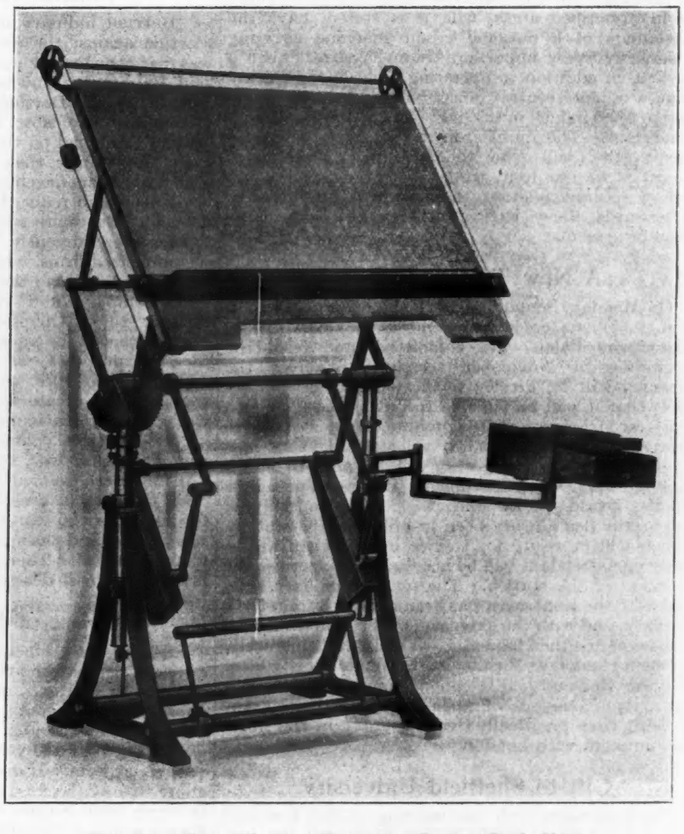


FIG. 54—"HALL-MARK" DRAWING TABLE—B. J. HALL

The vertical electric copier which may be seen, in almost its original form, on the stand supplied the first practical form of electric photographic plan copying in the world. It was not long before the vertical copier was followed by a continuous copier through which the print and tracing were carried on an endless band. Both the Hall-Mark (illustrated in Fig. 53) and the Sterling copiers are shown, together with the latest methods of development.

In the drawing-office itself great improvements have been made, and the "Hall-Mark" table illustrated in Fig. 54, is a new design, which embodies essential rigidity with single foot-pedal control, both vertically and horizontally. Moreover, it is so designed that alterations of angle do not cause either the board or the counterweights to require a working area in excess of the dimensions of the board and stand, an important feature when drawing-office space is restricted.

Another exhibit consists of sheets of the "R C" brand of tracing cloths, the newest of which is Mansfield pencil cloth. Since this cloth was introduced a little more than a year ago, engineers and architects are finding that, by using it, they can frequently eliminate tracing altogether. The surface is prepared so that a dense black line can be obtained with a pencil. It can, moreover, be erased without spoiling the surface of the cloth, either by hand or with an Ariel electric erasing machine, which has been designed to remove even Indian ink or printing ink without injury to a reasonably hard surface.

A view of the Ariel machine is reproduced in Fig. 55. It is supplied with a universal motor, for either A.C. or D.C. current at pressures of 200 to 250 volts, while 100 to 150-volt supply can be used in special cases. It only weighs 24 oz. complete, and is started and stopped by the switch on the outer casing just above the handle.

Referring further to the use of pencil tracings, it may be stated that before going to the print room, a pencil tracing is fixed by being wiped with a prepared fluid, and in this condition it is claimed that it has the same permanence as an inked tracing. The firm also supplies a blue-print paper giving extra contrast—Ferrograph—for use with its pencil cloth, so that the prints will have the same sharpness as prints made from inked originals.

Another interesting exhibit is the Protector binding machine for the edges of tracings, which was fully described in our issue of November 25th last year. The binding machine puts a double strip of strong linen round the edges. The tracing is simply wound through the little machine, no heat is used, and no special skill is required.

Brief reference may also be made to the Radioscript reproduction process, which is an interesting development of commercial photography for engineering work. Actually the method employed is not so much a process as a body of skilled men who can reproduce a drawing, a blue print, or any opaque original, either to the same size or to any larger or smaller size which is required. The copies can, if necessary be reproduced on translucent material, so that photoprints can be made from them in the same way as from a tracing. The examples displayed, which include some reproductions from the pages of THE ENGINEER, suggest the use of this process for making neat sets of reduced designs for convenient reference in an office or board-room.

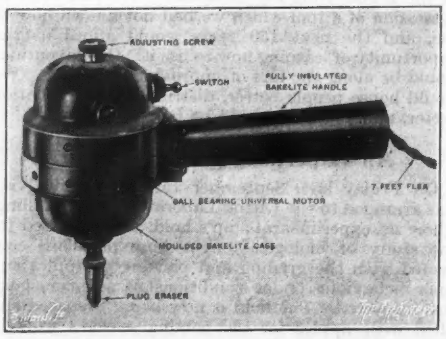


FIG. 55—ARIEL ELECTRIC ERASING MACHINE—B. J. HALL

THE BRITISH OXYGEN COMPANY, LTD.

Besides the exhibits described in a Supplement to our issue of September 8th, the British Oxygen Company, Ltd., is exhibiting two small compressors, one for air pressures up to 3000 lb. per square inch and the other for gas pressures up to 150 atmospheres, both of which are illustrated in to-day's Supplement.

The air compressor is a standard four-stage, two-crank, trunk type machine, with a maximum output of 70 cubic feet of free air per minute, and is one of a series. The crank case is totally enclosed, and all moving parts are pressure lubricated. Centrifugally cast renewable liners are fitted in the cylinders; the air valves are easily accessible, and since the suction and delivery valve for each stage are combined into a single unit, both valves can be removed and inspected at one operation. Careful attention has been given to the cooling of the air between stages. The first stage intercooler is of tubular form and is built into the frame of the machine, while the second and third intercoolers and the after coolers are coils immersed in the cooling tank surrounding the top cylinders. A final separator for removal of oil and water purifies the delivery air. The machine has been built especially to meet the demand for a moderately priced high-class compressor for use in connection with high-pressure work, and for small oxygen plants.

The gas compressor, which we illustrate in the Supplement, Fig. XIV., is the smallest of a standard range of machines manufactured by the company for high-pressure gas compression. It is a two-crank type, and compression is effected in two stages. All the motion work is totally enclosed and is very simple. The cylinder lubrication is effected by water which is an essential for maintaining gas purity. This machine has been specially constructed for dealing with small volumes of gas, and is designed to compress to a working pressure of 150 atmospheres. It is also suited for the compression of rare gases used in laboratories, &c., and for filling oxygen and other gas cylinders.

PERMAN AND CO., LTD.

We illustrate in Fig. 56 the first British Kromhout marine oil engine to be built in this country by John G. Kincaid and Co., Ltd., under the agreement with Perman and Co., Ltd., recently announced in our columns. The second engine, we are informed, is now approaching completion, and will shortly be delivered for use in one of the new motor vessels of Coast Lines, Ltd. As Fig. 56 shows, the Olympia engine is a three-cylinder model, complete with a hand-operated reversing clutch, but all engines over 200 B.H.P. are reversed by compressed air. It has a designed output of 150 B.H.P. at 320 r.p.m., with a cylinder bore of 265 mm. and a stroke of 350 mm.

The engine operates on the two-stroke cycle, with crank case compression and airless fuel injection, and is started by compressed air, a small air compressor being mounted at the clutch end of the engine on the bridge casting of the reverse gear. The same position on the engine has been chosen for the plunger type bilge and circulating water pumps, which are arranged at the two ends of the bridge casting. The mechanical lubricators are driven from the crank shaft and are placed near to the clutch. A feature of the engine is the heavy scantlings of both engine and clutch, which are specially designed for marine service, with, if necessary in the case of some of the smaller ships, unskilled attention. The question of easy accessibility has been kept in mind, and each cylinder can be dismantled without having to break the joints and pipe connections of the others. The three-part jointing of the exhaust pipe to facilitate this may be noted. Other features of the engine include the patented Kromhout roller plate gudgeon pin, and the grouping of the fuel pumps, starting cams, and governor with its controls, on a vertical shaft drive at the fly-wheel end of the unit. The engine is supplied with pressure lubrication, both to the main bearings and the clutch gear, and mechanical lubrication for the main cylinders, the system including oil filters and a large oil cooler. The rated fuel consumption is 0·40 lb. of oil per B.H.P.-hour, with a ten per cent. tolerance. When the engine has been run in, after, say, running in daily service for a month or six weeks, the consumption of lubricating oil works out at about 0·005 lb. to 0·006 lb. per B.H.P.-hour.

The engine is furnished with ball bearing thrust blocks, which take both ahead and astern thrusts, and which are lubricated by wick type oil feeds. In the case of the larger engines, which are reversed by compressed air, a Michel pattern of thrust block is used. Although the engines we have described are manufactured by Messrs. Kincaid, the sole selling rights are in the hands of Perman and Co., Ltd., which firm also provides installation and maintenance facilities and spare part service at its Bermondsey service department.

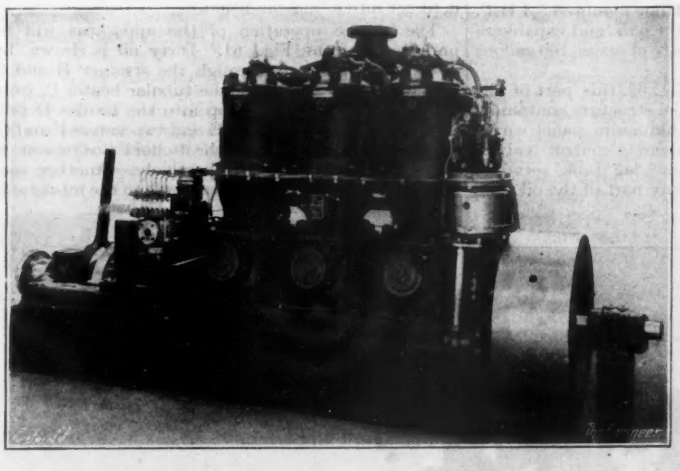


Fig. 56—150 B.H.P. British Kromhout Oil Engine—Perman

THE JOHN THOMPSON ASSOCIATED COMPANIES.

A large exhibit on the stand of the associated companies of John Thompson, Ltd., of Wolverhampton, comprises the fusion welded boiler drum and dished end illustrated in Fig. 59. The thickness of the plate is 1½in. and the designed working pressure 750 lb. per square inch. The firm has specialised in electric and water gas welding for many years past, and has evolved a welding technique which it claims is outstanding in British boiler engineering service. The electrodes used are manufactured by the firm itself, from a formula which has been found particularly suitable for large boiler work. The shielded arc system is used, and the method employed has been arranged to deposit the minimum amount of slag, thereby avoiding inclusions in the weld.

The machine, which has been recently installed for this very special work, is designed for a range of ampères up to 1000 with a corresponding graduation of voltage. With this machine the speed of welding has been advanced to many times more than that of the older type of machine, and the efficiency of the weld has been increased. The test pieces exhibited have, in many cases, shown an elongation up to the maximum, and have broken in the solid plate leaving the weld intact.

The dished end illustrated in Fig. 59 is an example of the firm's press work, which is done in a range of presses up to 3000 tons capacity. Water gas welding is also a speciality of the firm, and examples of water gas welding are provided by two types of marine furnaces, in which the weld is both corrugated and flanged. The John Thompson patented annealing cover—Fig. 57—also illustrates a typical water gas weld. The cover is made from a plate equal in length to twice the depth of the pot plus the length of the bottom, and in width equal to the width of the pot plus the width of one side. At the appropriate positions near the centre of the length of the plate two deep right-angled notches are cut opposite each other on each side forming a W contour. The sides are then flanged in at right angles, and on lines carried through the bottoms of the notches, and on bending across two transverse lines joining the bottoms of the notches, the plate edges meet in a Y, which is welded, thus forming a rectangular vessel. This special one-piece welded construction has been chosen because, when inverted in the furnace covering the parts to be annealed, the flames of the furnace sweep over solid metal corners giving a longer life to the cover.

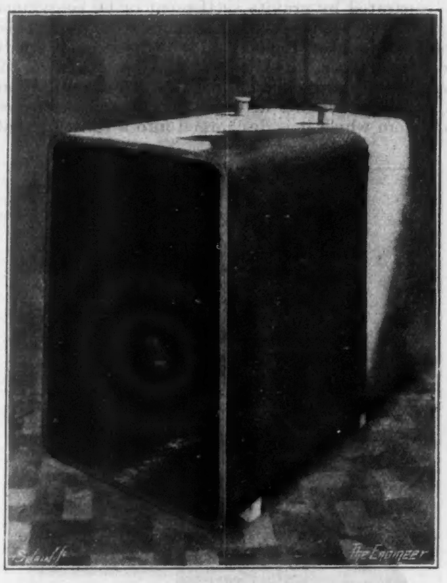


Fig. 57—Gas-Welded Annealing Cover—Thompson

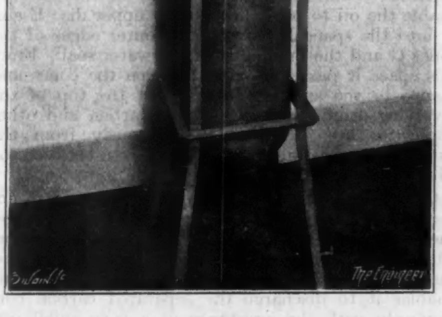


Fig. 58—Dejector Scale Preventer—Thompson

Another welded vessel illustrates the work of the firm's chemical and general engineering department, and is a mild steel pan homogeneously lined with lead. Such lead-lined vessels have been constructed in diameters up to 13ft. and 16ft. in height without creepage, and to withstand the action of acids under pressure, vacuum, and high-temperature conditions, which, even two years ago, would have seemed too severe. Similar work includes special antimony and lead linings for vessels, pipes, and coils. The lead linings referred to have been applied to cast iron, bronze, copper, and Monel metal articles. A stainless steel vessel is also shown on this stand. It illustrates the recent development in this particular metal and its electrical welding, which is carried out by the Dudley branch of the firm. The welding technique for stainless steel has now been so far developed by John Thompson that supply pipes, and vessels of considerable dimensions, can, we are informed, be constructed from, or lined with, 16 gauge or even 18 gauge stainless steel. This department also specialises in the jacketing of stainless steel vessels with mild steel, and the lining of mild steel vessels and wooden vats with stainless steel. Though not shown at Olympia, vessels made in British-made nickel-clad steel by the firm are also among the very latest examples of chemical and industrial engineering practice.

Other exhibits include an example of the John Thompson vertical economic boiler adapted for marine work. The firm's boiler plant production also includes a simple form of steam trap, the copper-nickel balls of which are true to 0·003in., an indication of the accuracy required in modern boiler work. Other sections of the stand have been designed to display the Kennicot pressure-type of water softener, a 3ft. diameter example of which is shown. It is designed to work at 75 lb. per square inch. The base exchange material used is a natural non-porous mineral, "Kenzelite," which has a high resistance to disintegration. Common salt is used as the regenerative agent.

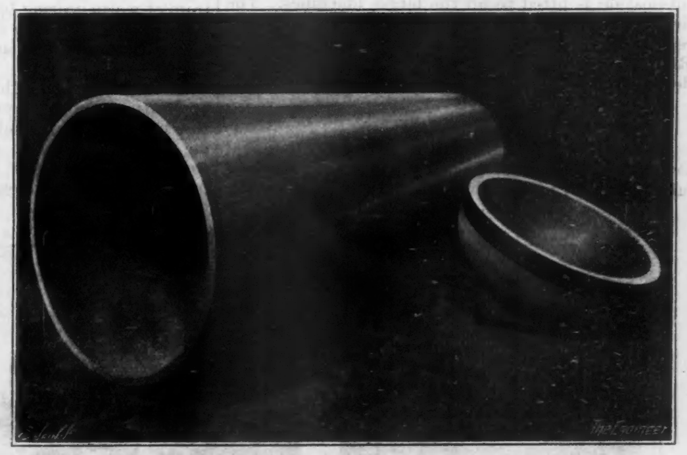


Fig. 59—750 Lb. Pressure Fusion Welded Drum—Thompson

In Fig. 58 we illustrate the Kennicot patented Dejector purifier, which is a simple apparatus designed to keep steam boilers free from mud and scale. The boiler water is continuously circulated through the Dejector, which delivers a controlled dosage of soda ash solution. The circulation is so arranged by means of a central down tube and a baffled upward flow that the precipitated hardening salts and suspended matter are continuously removed from the water and deposited in the Dejector, from which they can be blown off at intervals. The apparatus illustrated is made in various sizes to suit different boiler capacities, and is used for railway locomotives, marine boilers, and oil field work.

J. AND E. HALL, LTD.

The stand of J. and E. Hall, Ltd., of Dartford Ironworks, Kent, is noteworthy in that, for the first time, three new designs of CO_2 and ammonia gas compressors are shown. They are all illustrated in to-day's Supplement. The largest exhibit—see Fig. VI.—is a marine type horizontal twin enclosed single-acting CO_2 machine, which has been specially designed for high-duty service on modern meat-carrying vessels, and is electrically driven by a motor coupled to the fly-wheel shaft. The machine may, however, also be driven by an oil engine or steam engine and provision is made for bolting the prime mover base-plate to that of the compressor. The balanced crank shaft is of the solid pattern, machined from a single forging, and white metal lined bearings are used. The connecting-rods are of the marine type with split adjustable bearings both at the crank pin and forked crosshead ends. The crank pin brasses are white metal lined, while phosphor-bronze bushes are used on the crosshead ends. The forced lubrication system is complete with an Auto-Klean strainer on the suction side and a pressure gauge and relief valve on the delivery side. In order to supply pressure oil to the compressor glands a special hand pump is used. Both the compressor glands and the pistons are furnished with metallic packings. As our illustration indicates, the whole of the motion work is enclosed within light steel covers, the front half cover being removable for inspection purposes. The gas headers and the top valve boxes are all machined from solid steel forgings. This machine is of the new type now being supplied for motor cargo liners now under construction in the North of Ireland. Another CO_2 compressor is the twin single-acting machine illustrated in Fig. VII., which is arranged for working with intermediate liquid cooling, but can also be built to operate on the simple CO_2 compression cycle. It is specially suited for high-speed driving either direct or with a belt. In the usual arrangement the cast iron base-plate of the refrigerating machine and its motor is utilised as a casing for the condenser coils, thus forming a self-contained high-pressure side of the unit. The machine follows the maker's standard practice in the construction of valves and moving parts, and a feature in the design is the use of roller bearings and a ball type thrust bearing. This machine is particularly useful for ships' provision rooms and similar duties.

In Fig. IX. we illustrate a twin-cylinder vertical single-acting ammonia compressor arranged for V belt driving. The crank case and outer bearing form one casting and there are large inspection doors. The pistons are of the double trunk pattern with pressure rings in the top and bottom portions and an oil scraper ring and groove in the bottom portion. The suction valve is of the poppet type, arranged in the top of the piston, while the poppet discharge valves are on the safety head of each cylinder. The suction and discharge manifolds, are all in one casting. This embodies both the suction and the discharge stop valves, together with by-pass and pumping out valves. There is an easily removed strainer on the suction side of the manifold, together with an excess pressure safety device on the high-pressure side, which in a case of emergency will relieve the pressure back to the suction side. In the smaller sizes of these compressors splash lubrication is employed, but forced lubrication is fitted to all the larger machines. The firm is also showing a range of " Hallmark " automatic refrigerating machines, which enjoy a wide use in the Royal Navy and also in British and foreign mercantile fleets.

J. Stone and Co., Ltd.

The principal exhibit on the stand of J. Stone and Co., Ltd., of Deptford, S.E.14, is a new self-contained oil purification plant, which enables colloidal carbon to be removed continuously in the centrifuge without the use of chemicals. The Stone Empson process is based on the discovery that water properly atomised in an oil containing colloidal carbon acts as a perfect coagulant and its action is to neutralise the electric charge carried by the carbon particles and thus to stop the " Brownian movement " to which they are subject and which interferes with precipitation. The process is carried out in the Colloid Coagulator, which atomises the added water in the oil, after which the neutralised carbon particles rapidly coagulate into comparatively large clots, which can then be separated by gravity settlement or by centrifugal means. The Colloid Coagulator consists of a small disc rotor running at 10,000 r.p.m. It is provided with vortex passages, which create turbulence between the liquids and ensure the desired degree of atomisation. A detachable casing in which the liquid is collected and from which it is discharged into a time lag tank surrounds the rotor, which is driven through a single train of worm gearing by a " flange mounted " 1 H.P. electric motor running at 2800 r.p.m. and capable of operating the machine at the rate of about 100 gallons of dirty oil per hour.

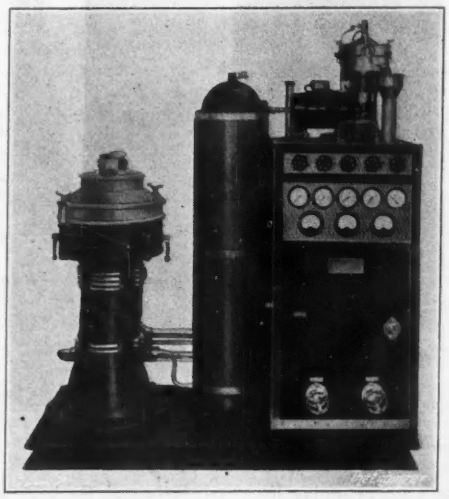


Fig. 62—Oil Purifier—Stone

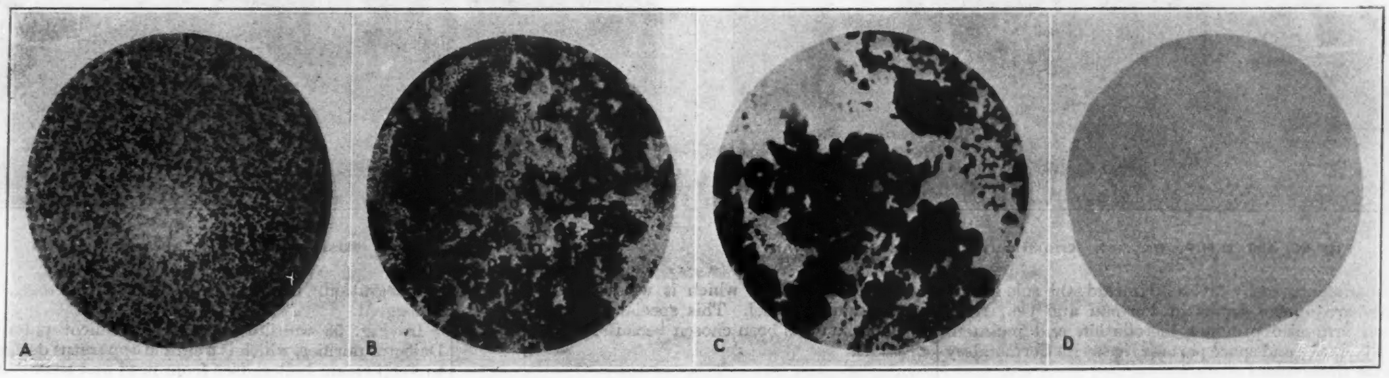


Fig. 60—Photo-Micrographs Showing the Effect of Oil Purification Process

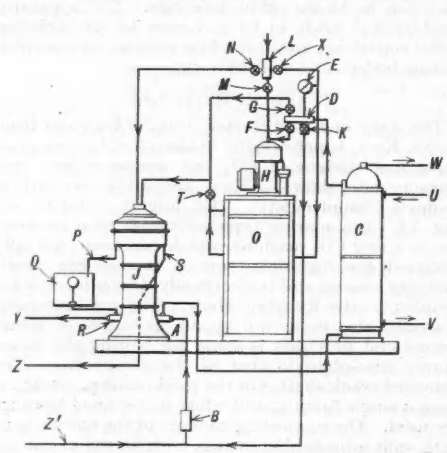


Fig. 61—Arrangement of Oil Purifier

As shown on the right of Fig. 62, this part of the apparatus is mounted on a steel structure containing the time lag tank and an aluminium panel carrying all the necessary instruments, control valves, &c. Baffles fitted in the time lag tank serve to prevent the direct passage of any part of the oil from the inlet to the outlet, and thus ensure a few minutes' delay for the agglomeration of the neutralised carbon particles.

From the tank the oil passes to the Ultra Centrifuge, to be seen on the left of Fig. 62. This machine has been designed to deal with oil in the condition described and has a preliminary separating space A —Fig. 63—inside the revolving drum, which enables the more readily separable particles of water and clots of carbon to be discharged direct to the walls of the drum without being re-mixed with the oil, which passes over the inner edge of a horizontal baffle B immersed at its outer periphery in the water seal C. Separate channels D are provided in this disc to enable the oil to pass through the upper disc E and so into the space F between the outer edges of the cones G and the inner side of the water seal. From this space it passes inwards between the cones and thence to the annular outlet H at the top of the revolving drum, while the water, carbon and other impurities are discharged continuously from the outlet I, the distribution of oil being even between the whole of the cones.

Contrary to the usual practice, the cones are not perforated, and as the oil enters from the outer edges the whole area of the cones is used for separation, which is mainly effected in the zone of the highest centrifugal force. The construction of the drum enables it to discharge the separated carbon continuously with the assistance of a very small percentage of hot water admitted with the incoming dirty oil, and the machine can run for very long periods without stops for cleaning. Provision has, nevertheless, been made for the convenient handling of the drum when, for example, this becomes necessary in order to change over from one kind of oil to another.

The motor and driving mechanism form an integral part of the frame and the high-speed drum spindle passes through the hollow motor shaft and is driven by a train of gearing with an automatic clutch which relieves the load on the motor when the machine is starting. This train of gearing also drives one of two oil pumps as required, the pumps being compactly fitted in the gear-box and easily detachable for inspection. Automatic lubrication is employed throughout. In the case of the apparatus exhibited the oil heater to be seen in the centre of Fig. 62 is steam heated, but when the apparatus is used in a sub-station or in any other place where steam is not available an automatically controlled electric heater is supplied.

As internal combustion engine oils frequently contain lighter volatiles, which should be removed, the dome cover of the heater is fitted with a patented automatic relief valve, which discharges any accumulation of gases, and where this discharge is appreciable a condenser may be fitted to recover the volatile fraction. Each centrifugal machine is provided with an electrical tachometer on the instrument panel, which also carries an indicator for showing the amount of oil in gallons per hour passing through the Colloid Coagulator. All the controls have been centralised with a view to facilitating operation.

The amount of water used in the colloid coagulator is rarely above 1 per cent. of the oil being treated and is said to be completely removed by the ultra centrifuge. With the apparatus oil that has been in service for such a long period that it had to be condemned has been restored to a brilliant condition and perfectly fit for further service. Instead of allowing the coagulated oil to pass to the ultra centrifuge it may be led to settling tanks; but, needless to say, this greatly adds to the time required for the purifying process. Users of the apparatus are recommended to treat the first supply of clean oil and never to allow it to get into a bad condition.

The precise operation of the apparatus will be understood from Fig. 61. Dirty oil is drawn by means of a pump A through the strainer B and is forced into the bottom of the tubular heater C, from which it emerges at the top into the header D provided with a thermometer E and two valves F and G, which communicate with the Colloid Coagulator H and Ultra Centrifuge J respectively. Another connection from the header passes back to the intake side of the strainer through a relief valve K, thus enabling the flow to either machine to be regulated on the pressure side by means of the valves mentioned.

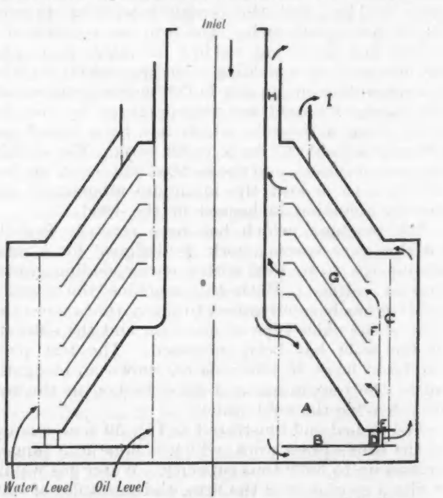


Fig. 63—Diagrammatic Section of Ultra-Centrifuge—Stone

Hot water derived from any convenient source is supplied to the header L, from which it passes to the Colloid Coagulator and ultra centrifuge by means of the valves M and N respectively. From the heater the oil passes through the Colloid Coagulator H into the tank O and over into the Ultra Centrifuge J, where it is separated from the carbon, water and other foreign matter and then discharged through the pipe P to the tank Q, which contains a float-operated valve communicating with the suction side of the pump R, the function of the valve being to maintain a certain head of oil so that any entrained air is released whilst no air can be drawn through the pump to cause frothing in the discharge pipe.

The pump R delivers the clean oil back to the engines or storage tanks, while the separated water and dirt are discharged from the Ultra Centrifuge at S. Provision is made for running the latter without the coagulator, which can be brought into service whenever the oil shows signs of blackening. In such cases the output of the apparatus can be raised to 250–300 gallons per hour. Under these conditions the valves F T are closed and the valve G opened, thus allowing the dirty oil to pass direct from the heater into the centrifuge. The steam supply to the oil heater enters at U, a trap being provided at V to drain away the condensate. The gas relief valve is indicated at W, whilst X is the valve which serves for feeding hot water into the time lag tank O to float off the remaining oil into the ultra centrifuge when stopping the plant. The pipes shown at Y, Z, and Z^1 serve respectively as the clean oil delivery, the waste to bilge, and the dirty oil inlet. An analysis of internal combustion engine oil before and after treatment is given below.

	Before.	After.
Carbon	2·5%	Nil
Water	2·9%	Nil
Acidity (in terms of SO_3)	0·21%	0·07%
Specific gravity at 60 deg. Fah.	0·924	0·905
Viscosity Redwood at 70 deg. Fah.	2048 secs.	1526 secs.
Viscosity Redwood at 100 deg. Fah.	687 secs.	540 secs.
Viscosity Redwood at 140 deg. Fah.	219 secs.	184 secs.

The photo-micrographs, Fig. 60, illustrate the effects of the process. Dirty lubricating oil from internal combustion engines is shown at A, the same oil after coagulation at B, the carbon, &c., discharged from the oil separator at C, and the purified oil at D.

W. H. Allen, Sons and Co., Ltd.

Without doubt, one of the most attractive displays in the exhibition is that arranged by W. H. Allen, Sons and Co., Ltd., of Bedford, comprising, as it does, oil engines, steam turbines, steam engines, pumps, D.C. generators and motors, control gear, fans, &c., both for marine auxiliary and for industrial purposes. From the many interesting exhibits we have chosen one or two for illustration.

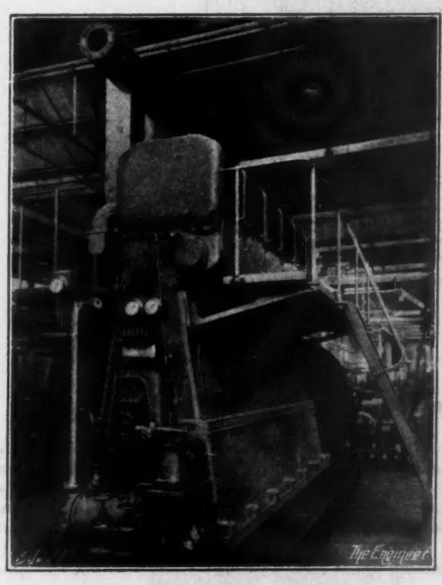


Fig. 64—550 B.H.P. Six-Cylinder Oil Engine—Allen

The largest oil engine is the six-cylinder unit illustrated in Fig. 64, which has a designed output of 550 B.H.P. at 350 r.p.m., the cylinder bore being 350 mm. and the stroke 470 mm. A smaller engine, which we do not illustrate, is the six-cylinder 150 B.H.P. unit, an example of the firm's steel construction giving low weight for marine and land transport purposes. The design features of these engines have been referred to in our pages from time to time, and we need not again describe them.

A new engine designed for marine propulsion work is illustrated in Fig. I. of to-day's Supplement. It is a four-cylinder, 134 B.H.P. engine running at 500 r.p.m. with a bore of 230 mm. and a stroke of 300 mm. It is complete with auxiliary water pumps and a compressor for starting air. A feature of this engine is the neat form of reverse gear. It consists of a drum incorporating nickel steel bevel pinions, which mesh with a driving wheel on the crank shaft extension and with a driven wheel on the reverse shaft. On the other side of the brake drum is mounted a plate type friction clutch housing, the main clutch member forming part of the reversing shaft. A cast iron contracting brake is mounted on the drum, the contracting mechanism being interconnected with the lever operating the plate clutch. With the manœuvring lever in the vertical position, the clutch is disengaged and the brake free. The drum and clutch housing are free to rotate in the same direction as the crank shaft, the reverse shaft being stationary. When the lever is moved to the ahead position the plate clutch is engaged, locking the clutch housing and drum solidly with the driven wheel and reversing shaft; thus the driven wheel and pinions cannot move relatively. The whole unit is, therefore, driven in the same direction, and at the same speed as the crank shaft, the load being transmitted through the clutch. When the manœuvring lever is moved to the astern position, the plate clutch is released and the hand brake contracted, gripping the drum and holding it stationary. The pinions are now free to rotate and transmit the drive from the crank shaft wheel to the driven wheel and reverse shaft in the "astern" direction. A thrust bearing is provided on the shaft within the gear case. This type of reverse gear is particularly well suited, it is claimed, for control from the bridge.

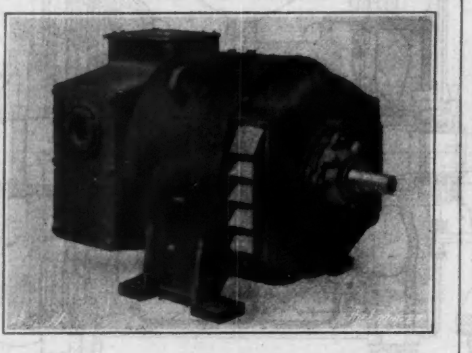


Fig. 65—D.C. Ventilated Drip-Proof Motor—Allen

The 50 kW turbo-generator illustrated in Fig. X. in the Supplement is designed for auxiliary purposes on board ship, or for use as a pilot set in conjunction with a large turbo-generator set. It is of the single-stage impulse type. The speed governor is of the centrifugal type, and is driven by a vertical shaft at the steam end through a worm and wheel, the governor operating the throttle valve through an oil relay.

The reduction gear incorporated in the design is of the single helical type, with the pinion made integral with the turbine rotor shaft. The turbine has been designed to exhaust against a vacuum or back pressure, and a hand valve is provided to enable it to operate economically under the different exhaust conditions.

The turbine-driven axial flow pump, shown in the Supplement, Fig. XI., consists of a single-stage impulse turbine direct-coupled to the pump, and is a typical example of modern practice in respect of main circulating pumps.

The pump casing and rotor are constructed from highest quality gun-metals with a forged bronze shaft, an inspection door being provided to give ready access to the moving parts without disturbing the main pipe connections.

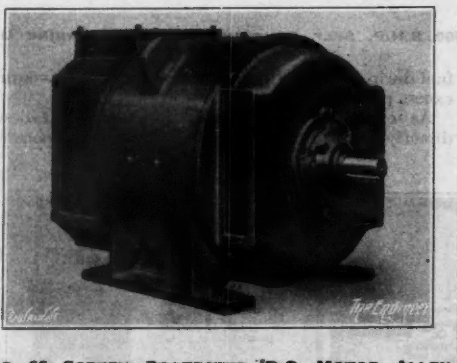


Fig. 66—Screen-Protected D.C. Motor—Allen

The electrical exhibits consist of D.C. generators and motors and control gear designed to meet Lloyds and other official requirements. Enclosed ventilated, pipe ventilated, and totally enclosed machines for vertical and horizontal operation, are shown. All the machines are built on robust lines, and all the internal parts can easily be inspected. The machine shown in Fig. 65 is a ventilated, drip-proof motor, and that in Fig. 66 a screen-protected motor. Ball and roller bearings are fitted as standard practice, but, if desired, sleeve-type bearings with ring lubrication are provided. The brushes are carried in non-ferrous cast boxes and provision is made for accurate brush setting. Mica is the basis of all the insulation, which is reinforced with other materials to avoid flaking.

The control gear exhibits consist of drum-type and automatic panels, designed on similar lines, for constant and variable-speed motors, and suitable for floor or wall mounting. The cases are composed of stout steel plates with easily removable hinged doors with inspection windows. All the panels are constructed on the unit principle. Starting is done in the case of the drum-type panels by the operation of a metallic drum with renewable copper contacts, the drum being turned by a hand wheel to be seen at the side of the panel shown in Fig. 67. A mechanical detent holds the drum in the "full on" position, but if it is released before the starting operation is completed, it is returned to the "off" position by a powerful spring. All the resistance units consist of non-corrodible alloy wire wound over suitable insulation on metal tubes, the starting units being rated on a one minute basis, and are proportioned to start the motor against full load torque. An electro-magnetically operated contactor switch makes and breaks the circuit. Failure of voltage or any other trouble that may lead to the de-energising of the operating coil causes the contactor to open, and owing to the provision of interlocks it cannot be closed again until all the starting resistance has been re-inserted. The overload trip, which is of the self-setting solenoid type with a time lag device, permits of adjustment between full load and 100 per cent. overload. To ensure that the circuit is always broken on the contactor, the double-pole isolating switch is interlocked with the contactor.

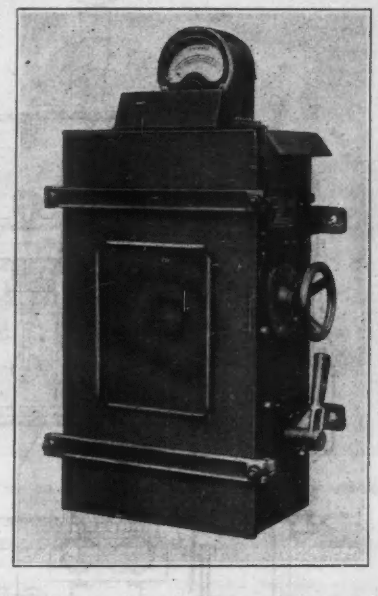


Fig. 67—Drum Type Starting Panel—Allen

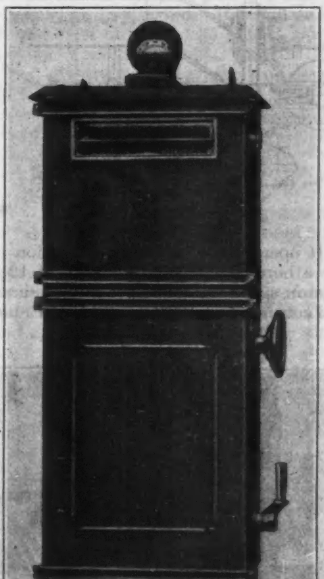


Fig. 68—Drum Type Variable Speed Controller—Allen

In the case of the variable-speed panels, as shown in Fig. 68, a shunt field regulator of the straight-line type, is screw-operated by an external handle, and is interlocked with the contactor operating coil to prevent the motor being started without full excitation.

The automatic panels comprise a number of electro-magnetic contactor switches and starting resistances, as used in the drum panels, the sequence and time of operation being controlled by a relay on each switch, independently adjustable for timing to suit conditions. Starting and stopping is done by push-buttons mounted on the case or at some remote point, or by control devices such as float or pressure switches.

Belliss and Morcom, Ltd.

The principal exhibit on the stand of Belliss and Morcom, Ltd., of Ledsam-street Works, Birmingham, is the 200 B.H.P. six-cylinder oil engine driven generator set illustrated in Fig. III. of to-day's Supplement. It operates on the airless injection principle, and has a bore of 8½in. and a stroke of 12½in. The mean piston speed is 1250ft. per minute, and the full load fuel consumption 0·39 lb. per B.H.P.-hour. The main features of this engine were described in The Engineer of February 17th, 1933, so that we only need to emphasise a few special points. Although a totally enclosed design has been adopted the light aluminium covers are easily removable. The cylinder head joints are subjected only to gas pressure, a separate water connection, which is easily accessible, being used between the cylinder and the cylinder head. An attractive feature is the single-wheel control gear, which provides for careful regulation of fuel during the starting revolutions, thereby avoiding excess pressures.

As exhibited at Olympia the engine is shown directly coupled to a Crompton-Parkinson generator.

Another important exhibit is the 1500 B.H.P. 4500 r.p.m., self-contained turbine, which we illustrate in Figs. 69 and 70. The condenser, which is of the firm's squat type, and will be seen in Fig. 69, is not exhibited at Olympia, only the bottom half casing of the turbine with the rotor and governor box being shown. The turbine is a sixteen-stage Rateau machine, designed for a steam pressure of 160 lb. per square inch, and 500 deg. Fah. steam temperature. The rotor blades are of stainless steel and Monel metal is used for the casing blades. A feature of the arrangement—see Fig. 69—is the centre suspension of the turbine unit to provide for expansion. The governor control gear conforms with Belliss and Morcom standard practice. Part of this gear is shown in Fig. 70, which illustrates the unit in course of erection in the maker's works. The drawing we reproduce shows the general lay-out of the vertical-spindle turbine-driven condensate pump. A separate motor-driven circulating pump is provided.

A small unit of unusual interest is the Midget horizontal turbine and condenser, illustrated in Fig. 71. It is coupled to a ½-kW generator by Higgs Motors, Ltd., of Witton; and works at 50 lb.

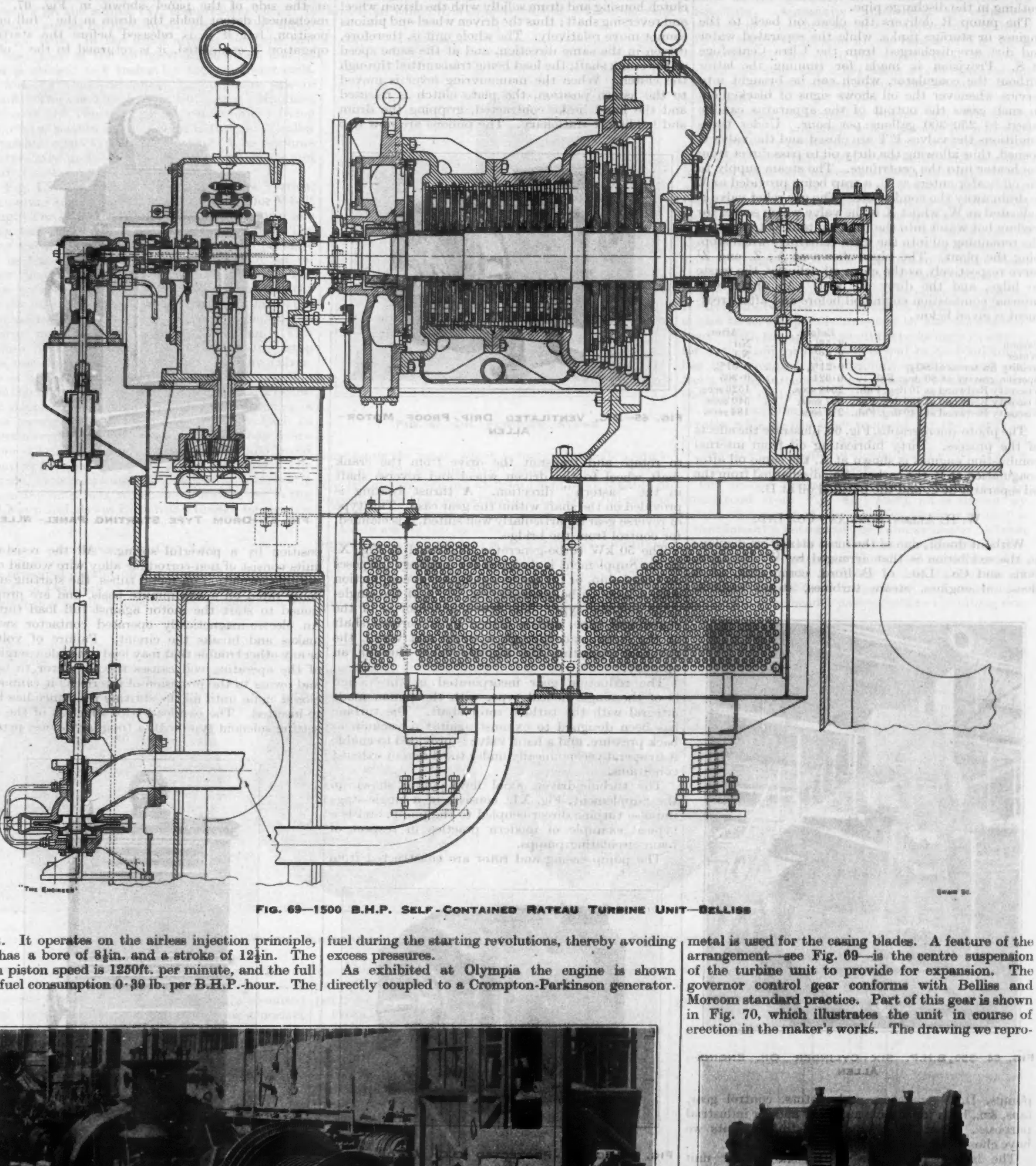


Fig. 69—1500 B.H.P. Self-Contained Rateau Turbine Unit—Belliss

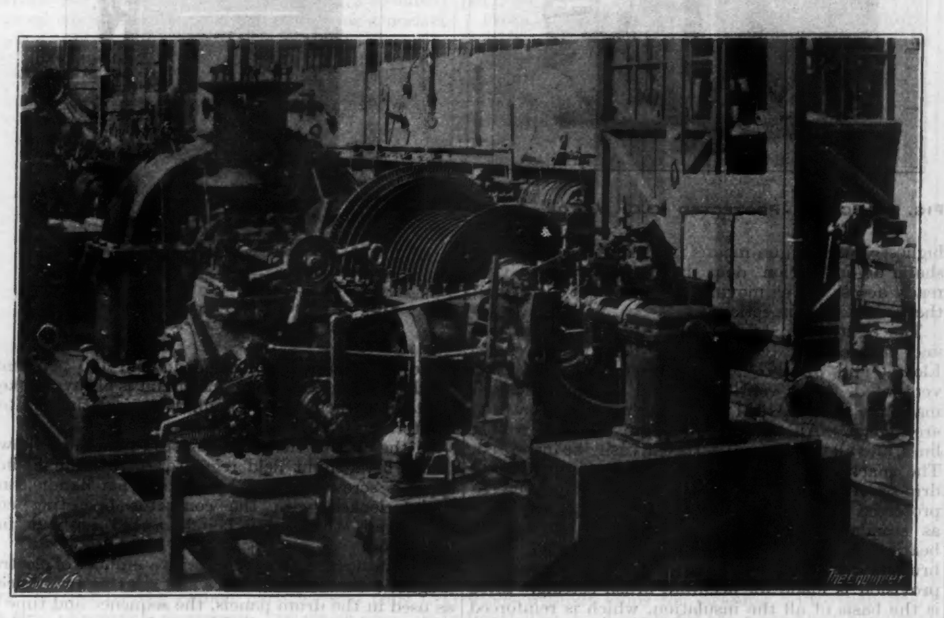


Fig. 70—Turbine in Course of Erection—Belliss

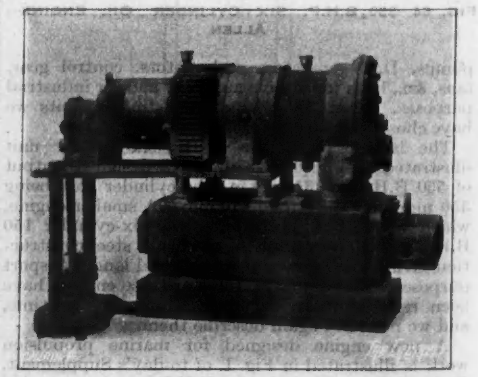


Fig. 71—"Midget" Turbo-Generator—Belliss

pressure, or with 100 lb. pressure an output of 4 kW is obtainable. The turbine is of the two-pass velocity impulse type, and is controlled by a Pickering type governor. The unit illustrated is complete with condenser and turbine-driven condensate pump, a separate supply of condensing water being assumed. The same turbine can be supplied in a vertical form, and the design is regarded as particularly suitable for locomotive lighting and industrial service. The Belliss and Morcom steam reciprocating engines are still in demand, and the firm is exhibiting a two-crank compound engine coupled to a 50-kW Crompton-Parkinson generator, which is one of two sets for a new G.W.R. steamer. On the same stand there is a display of Arca type regulators for boiler and industrial steam control, demonstrating the varied uses of this type of plant.

REAVELL AND CO., LTD.

A full and varied range of air-compressing plant makes an attractive exhibit on the stand of Reavell and Co., Ltd., of Ranelagh Works, Ipswich. One of the large exhibits is a 1000 cubic foot two-stage, two-crank, air compressor, with a 12in. H.P. cylinder and 21in. L.P. cylinder, and a stroke of 9in., which is of the same type as the 1500 cubic foot machine illustrated in Fig. 72, but is exhibited without a motor, along with a 500 cubic foot machine. These compressors are taken from a range extending from 400 cubic feet up to 5000 cubic feet at pressures from 120 lb. to 150 lb. per square inch, the machines being fitted when desired with automatic unloaders.

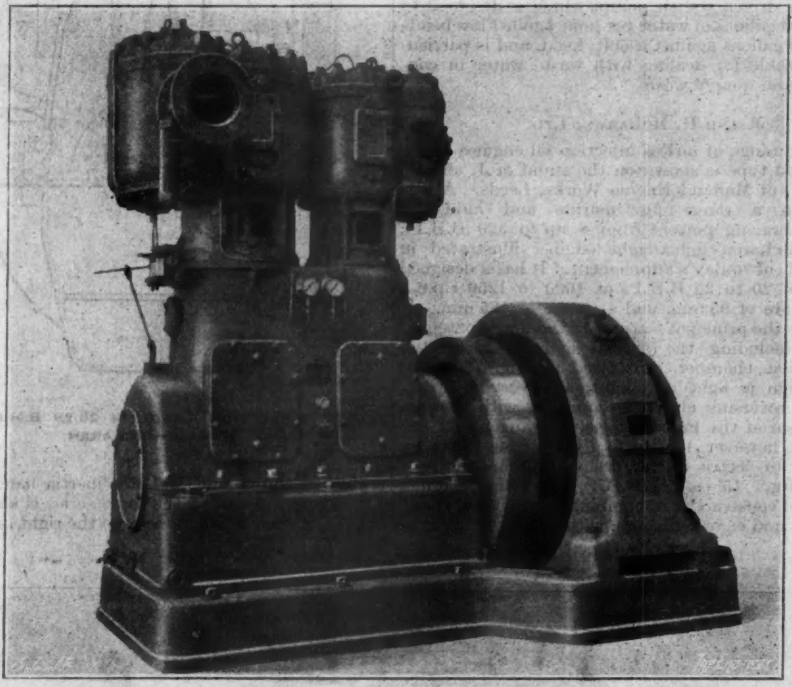


FIG. 72—1500 CUBIC FOOT MOTOR-DRIVEN COMPRESSOR—REAVELL

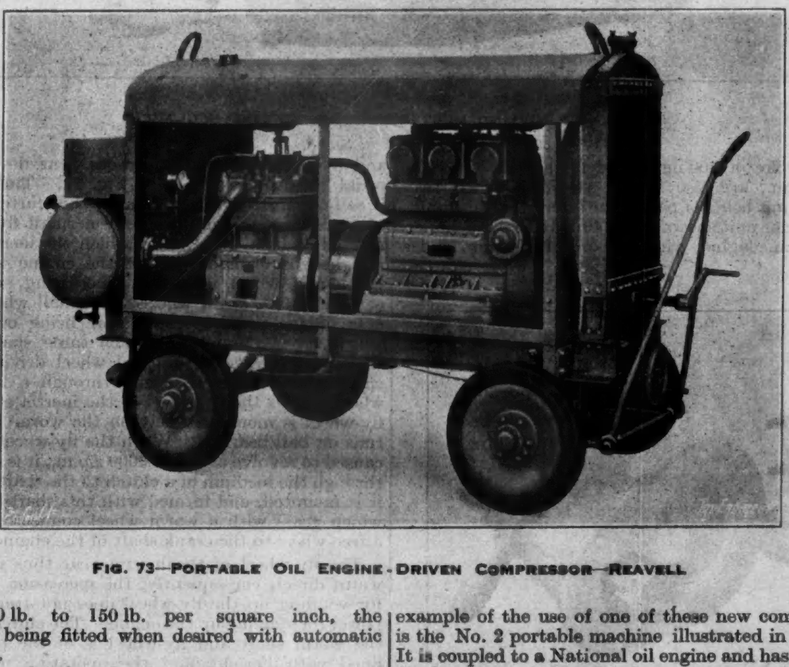


FIG. 73—PORTABLE OIL ENGINE-DRIVEN COMPRESSOR—REAVELL

The firm is also showing a complete range of vertical, two-crank, two-stage, water-cooled compressors for pressures of 450 lb. and 1000 lb. per square inch, which are employed for charging air bottles for starting internal combustion engines, for pipe and vessel testing, and similar uses. Another interesting group is composed of four machines taken from a range of eleven single-acting, single-stage compressors, giving a range of 200 to 300 cubic feet of free air per minute when delivering to a final pressure of 100 lb. per square inch. The smaller machine is air-cooled, but the others are water-jacketed, and a new model is the three-crank machine illustrated in Fig. VIII of the Supplement. It has a designed capacity of 300 cubic feet per minute. This same series of machines can quite well be used for vacuum purposes.

A new development in rotary, rolling, drum-type air compressors and exhausters is the water-cooled machine illustrated in Fig. 74, which is of the 8in. by 8in. size running at 115 to 1725 r.p.m., and designed for working pressures up to 30 lb. to 40 lb. per square inch. The use of a well-designed water jacket has enabled the pressure to be increased from 20 lb. up to nearly double that pressure. The range is manufactured in capacities from 25 up to 2000 cubic feet of free air per minute.

Several exhibits on the stand illustrate the new single-stage, twin-cylinder machines with piston-type suction valves, which are designed for portable compressor work and run at 1000 r.p.m., delivering air at 100 lb. per square inch. A full description of this machine was published in THE ENGINEER of December 9th, 1932, when a description of the patented unloading valve was also given. An example of the use of one of these new compressors is the No. 2 portable machine illustrated in Fig. 73. It is coupled to a National oil engine and has a piston displacement of 118 cubic feet per minute, delivering air at 100 lb. pressure. The compressor will serve two to three of the firm's new B.A.L. type "John Bull" concrete breakers. Mention should also be made of the interesting range of five small rotary-type machines, suitable for working pressures up to 15 lb. per square inch, and vacuums of 20in. mercury. These have been introduced to meet the growing demand for light and compact units, having smaller capacities than the larger rolling-drum type compressors. They are largely used for oil burners, aeration, displacement of liquids, gully-emptying, for the operation of vacuum brakes on commercial vehicles, and for the priming of centrifugal pumps.

Other exhibits include a group of hand or belt-driven compressors, and a Reavell compressed air anchor winch, which represents a range of air-operated deck auxiliaries built by the firm for tugs, coastal boats, yachts, &c.

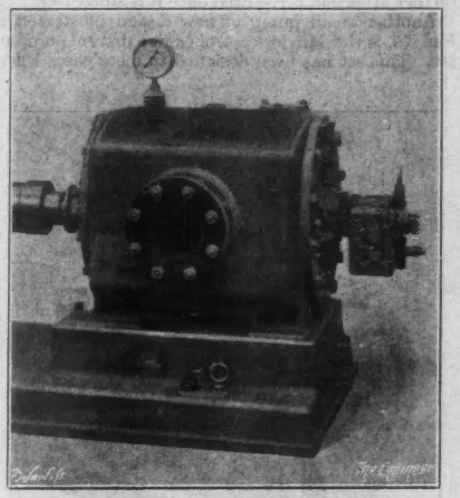


FIG. 74—ROLLING DRUM TYPE COMPRESSOR—REAVELL

Finally, there are exhibited on the stand three sectionalised Reavell-Ascania regulators, showing the operation of pressure regulators for low and high pressures, and for gas-mixing installations.

MIRRLEES, BICKERTON AND DAY, LTD., AND THE MIRRLEES WATSON COMPANY, LTD.

The principal exhibit on the stand of Mirrlees, Bickerton and Day, Ltd., of Hazel Grove, near Stockport, and the Mirrlees Watson Company, Ltd., of Glasgow, is the six-cylinder Mirrlees-Ricardo high-speed, four-stroke, airless injection oil engine, coupled to a standard Parsons 2 to 1 reducing and reversing gear, complete with thrust block propeller shaft and propeller, which is illustrated in Fig. II. of to-day's Supplement. The engine has a cylinder bore of 5⅝in. with a stroke of 6¼in., and a designed output of 120 B.H.P. at 1200 r.p.m. It is manufactured in two cylinder sizes of 20 and 50 B.H.P. per cylinder, with a range of powers of 60 to 400 B.H.P. As the engine has already been described in detail in our columns, no further comment on its design is necessary. A working model shows clearly the operation of the sleeve valve mechanism, and various parts of the engine are on view. Amongst the exhibits is a group of articles case-hardened by the Nitralloy process, the equipment for which has been installed at Hazel Grove, and the firm is prepared to undertake the hardening or the manufacture of component parts.

Photographs on the stand illustrate the Mirrlees direct-reversing, airless-injection, marine engines, which have been successfully employed in Thames tug work, and are now being embodied in an electric tug scheme.

Among the many pump exhibits of the Mirrlees Watson Company, Ltd., which include an 8in. single-stage, split-casing, centrifugal pump and a 4in. six-stage turbine boiler feed pump, is the vertical-spindle, self-priming pump, illustrated in Figs. XII. and XV. of to-day's Supplement. It has been developed for marine use, and the floor space occupied has been reduced to a minimum. The driving motor is mounted immediately above the pump, which is of split-casing design, with the suction and discharge branches at the back, thereby enabling the covers to be easily removed for inspection or overhaul. The air exhauster, which is of the rotary water-sealed type, is driven by a separate small motor, the motor and exhauster being built as a self-contained unit, which is bolted to a facing in the main pump frame. The opposite side of the frame carries a tank containing a supply of sealing water for the exhauster. The advantages claimed for this type of exhauster over the positive displacement rotary or reciprocating types are silence in operation, no lubrication difficulties, no rubbing surfaces in contact, and no danger of damage to the exhauster in the event of its drawing water. The suction of the exhauster is connected through a non-return valve to the highest point on the suction branch of the main pump and the exhauster discharge is led to the tank, sealing water circulating between the tank and exhauster all the time the exhauster is in operation. As the sealing water is kept separate from the liquid being handled by the main pump, the pump can be used for dirty or gritty liquid. The exhauster motor is controlled by the main pump starter and starts up along with the main pump, exhausting any air which may be present in the suction line. When the main pump gets water and pressure builds up in the volute, a pressure-operated switch comes into action and stops the exhauster motor. Should the main pump lose water, the switch automatically starts up the exhauster again, and it remains running until the main pump has been reprimed. The exhauster is thus only running when it is actually required, and wear and replacements are reduced to a minimum. The unit is silent in operation and, being entirely automatic in action, no further attention is required once it is started up.

Another small pump of new design illustrated in Fig. 75, is the Mirrlees petrol engine driven pumping set. This set has been designed to meet cases where no external source of power supply is available, and has a number of uses, such as for emptying gutters, supplying water for rural buildings, and general portable work for contractors. The model exhibited has a hopper-cooled $1\frac{3}{4}$ H.P. engine, and is mostly used for intermittent work, but for continuous running a tank-cooled model can be supplied. The pump is of the side suction type, the impeller being hydraulically balanced. At the coupling end, the shaft is carried on a ball bearing and a large gun-metal bush supports it close up to the impeller. Special attention has been paid to silencing, and two large thick-walled silencers are used, enabling the engine to be run indoors or in a confined space without objectionable noise. The capacity of the set is from 30 to 90 gallons per minute for heads up to 40ft.

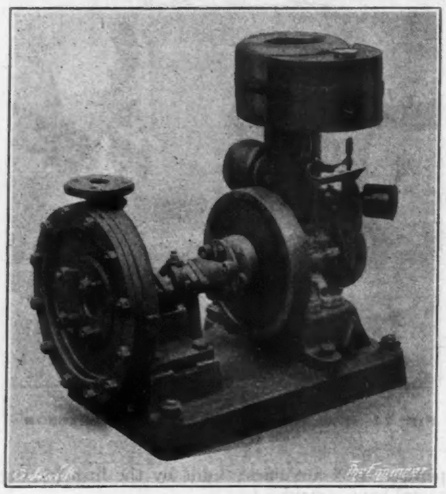


FIG. 75—PETROL ENGINE-DRIVEN PUMP—MIRRLEES

Another interesting pump exhibit is a compact motor-driven pump, in which the pump and motor are combined, the impeller being carried on the extended motor shaft. The impeller is of the single-entry type, with balancing shoulder at the back preventing any end thrust from coming on the motor bearings. The shaft is protected in the stuffing-box by a renewable sleeve. The discharge branch is on the top of the casing on the centre line, which makes alternative rotations unnecessary. Ease of installation is claimed for this new type of pump, which is designed for water supply and heating installations.

BROOM AND WADE, LTD.

The exhibit of Broom and Wade, Ltd., of High Wycombe, has been arranged to demonstrate under running conditions the firm's patented sleeve valve compressor, which is shown operating a wide range of "Broomwade" pneumatic tools. A view of the compressor, which was fully described in THE ENGINEER of September 11th, 1931, is reproduced in Fig. V. of to-day's Supplement. It has a piston displacement of 116 cubic feet, and is designed to deliver 100 cubic feet of free air per minute, when working at pressures up to 100 lb. per square inch. Another larger machine with mechanically operated valves is a 7in. by 8in. twin-cylinder unit, with a designed output of 130 cubic feet of free air per minute at pressures up to 120 lb. Several smaller machines of the reciprocating and rotary type are also on view. The main exhibit is, however, a display of drills and grinders actually in operation. In Fig. 76 we show the main component parts of a Broomwade multi-vane drill. The motor, which is of patented design, is of simple construction, the only wearing parts being the special fibre vanes which are easily and cheaply replaced, and give, we are informed, a long working life. The governor gear takes the form of steel balls housed in a conical race, which are moved out centrifugally and control the supply. The drills we inspected are silent in operation and free from vibration, and they cover the large drilling range of ¼in. up to 3in. diameter holes. Among the other exhibits worthy of special mention are a column-mounted yoke pattern riveter, and a neat form of pneumatically driven trench pump, which is designed to lift 10,000 gallons of water per hour against low heads and 3000 gallons against a 50ft. head, and is particularly suitable for dealing with waste water in contracting and quarry work.

J. AND H. McLAREN, LTD.

A wide range of airless injection oil engines of the high-speed type is shown on the stand of J. and H. McLaren, of Midland Engine Works, Leeds. A new model in a range for marine and industrial uses, embracing powers from 8 up to 320 B.H.P., is the McLaren lightweight engine, illustrated in Fig. XVI. of to-day's Supplement. It has a designed output of 20 to 25 B.H.P. at 1000 to 1250 r.p.m., with a bore of 95 mm. and a stroke of 125 mm. It embodies the principal features of the firm's patented design, including the special cylinder head and combustion chamber, illustrated in Fig. 78. The new design is light in weight, and very compact, and the reversing clutch is equipped with internal mechanism of the Parsons type. Arrangements can be made, however, for starting the engine either by hand, by an electric starter, or an air motor.

The larger 15 to $17\frac{1}{2}$ B.H.P. per cylinder units, which are constructed in combinations of two, three, four, six, and eight cylinders, with a bore of 135 mm. and a stroke of 200 mm., and for speeds of 800 to 1000 r.p.m., are also shown, the re-designed two-cylinder unit being of particular interest in this range. A still larger unit shown is the 40 B.H.P. per cylinder, 1000 r.p.m. engine, with a bore of 190 mm. and a stroke of 240 mm., which is supplied in four, six, and eight cylinder sizes. In Fig. 77 we illustrate the six-cylinder, 60 B.H.P. engine, which is equipped with a Parsons clutch, and McLaren inertia hand starter; a two-cylinder unit of the same series is also shown. The hand starter will be seen to the right of Fig. 77, and a section through a similar gear designed for pedal operation is given in Fig. 79. This drawing is self-explanatory. Essentially, the starter consists of an increasing gear, whereby a small fly-wheel is rotated at high speed, after which the inertia of the fly-wheel is utilised to start the engine through a worm and wheel. The first increasing mechanism comprises two chain wheels, the small wheel in the case of the pedal-operated gear being of the free wheel type. Mounted on the same shaft as the small chain wheel is a bevel wheel driving into a smaller wheel, which, again, through a large spur wheel, drives the fly-wheel of the inertia gear. This fly-wheel is mounted freely on the worm shaft, and runs on ball bearings. When the fly-wheel has been caused to revolve at about 3000 r.p.m., it is connected through the medium of a clutch to the shaft on which it is mounted, and formed with this shaft is a worm which gears with a worm wheel connected through a free wheel to the crank shaft of the engine.

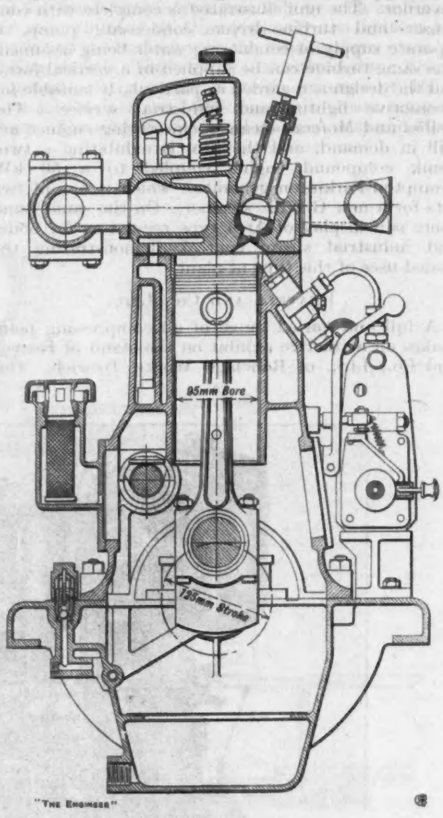


FIG. 78—SECTION THROUGH 20/25 B.H.P. OIL ENGINE—McLAREN

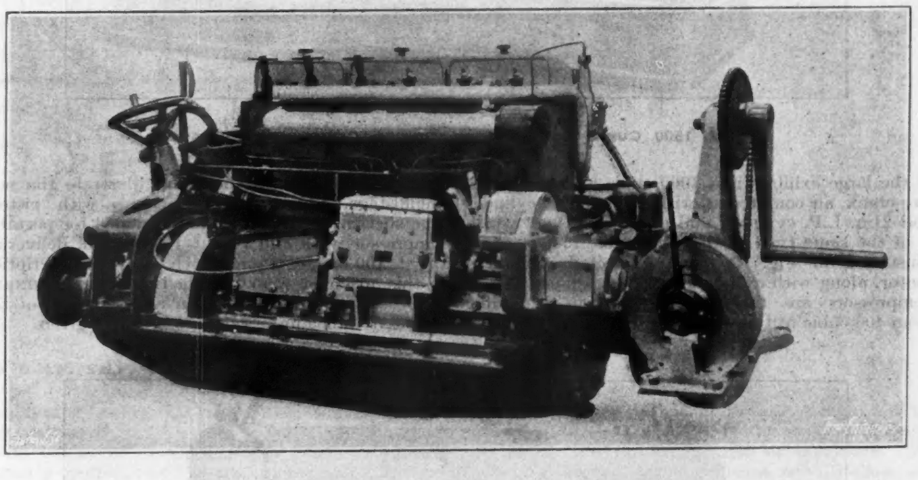


FIG. 77—SIX-CYLINDER 60 B.H.P. OIL ENGINE—McLAREN

The fly-wheel of the inertia gear thus drives the worm direct, consequently, the increasing gear used for winding up the fly-wheel does not transmit any power for starting up the engine. The clutch between the worm shaft and fly-wheel is of the plate type lined with Ferodo, and the operating mechanism for the clutch is so arranged that it is only necessary to pull the lever and slip in the clutch.

When electric glow plugs are used in connection with engines, the lever is so arranged that the current

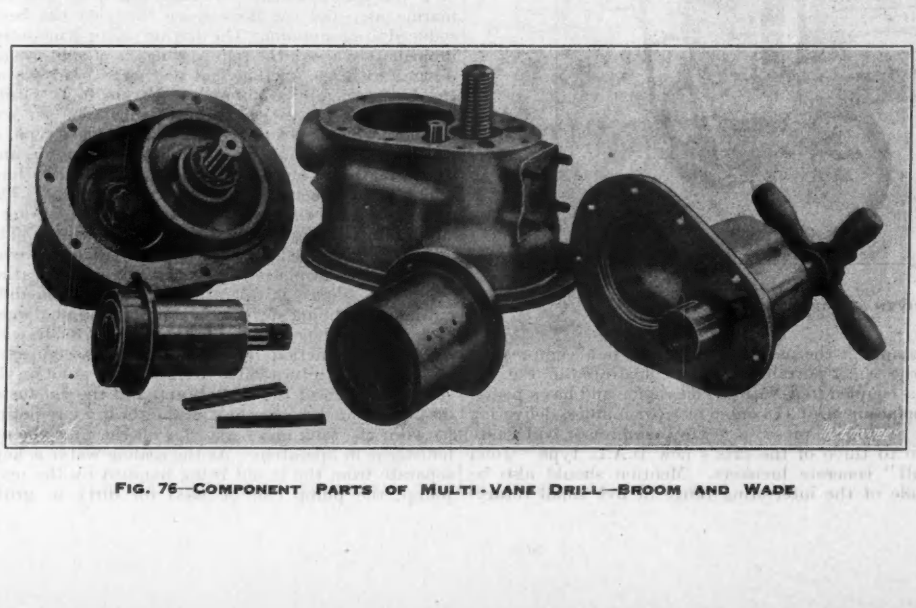


FIG. 76—COMPONENT PARTS OF MULTI-VANE DRILL—BROOM AND WADE

is cut off the plugs automatically immediately the clutch is let in to start the engine. In this case, of course, the electric glow plugs need only be switched on about ten seconds before the clutch is tripped.

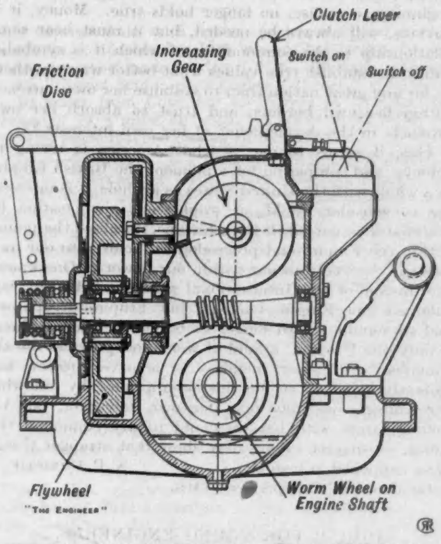


FIG. 79.—INERTIA STARTING GEAR—MCLAREN

RUSTON HORNSBY, LTD., AND RUSTON LISTER MARINE COMPANY, LTD.

The principal exhibit on the stand of Ruston and Hornsby, Ltd., of Lincoln, is a five-cylinder 150 B.H.P. auxiliary generator set running at 600 r.p.m. and coupled direct to a Sunderland Forge Company's 100-kW generator. This engine, which is illustrated in Fig. IV. in our Supplement, is one of eight similar units which are being supplied to Workman, Clark and Co., Ltd., for the motor ships "Ispingo" and "Inchanga," under construction at the company's Belfast yard for Andrew Weir and Co., Ltd. The principal features of this particular design of engine have already been dealt with in our pages. The fuel consumption obtained on the test bed works out to about 0·4 lb. of oil per B.H.P. hour at full load, 0·42 lb. at three-quarter load, and 0·45 lb. at half load. As several identical units have been in service for a considerable time, it is possible to state that, according to the makers' and users' repair and maintenance returns, the cost of upkeep is very small. A smaller Ruston-Hornsby engine also shown on the stand is the 96 to 104 B.H.P. six-cylinder unit, designed to develop the powers named at speeds of 900 to 1000 r.p.m. Both the engines run on the airless injection principle.

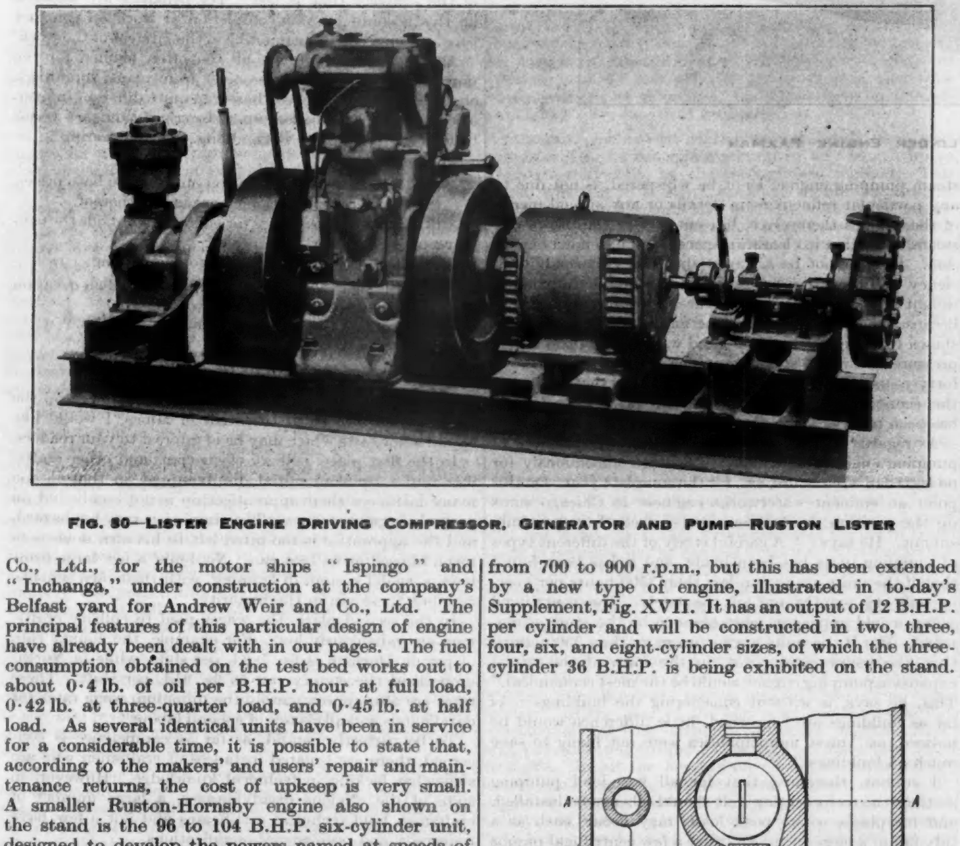


FIG. 80—LISTER ENGINE DRIVING COMPRESSOR, GENERATOR AND PUMP—RUSTON LISTER

The exhibits of the Ruston Lister Marine Company, Ltd., of Imperial House, Kingsway, London, W.C.2, include a four-cylinder 35 B.H.P. unit and a two-cylinder 17½ B.H.P. unit, both of which run at 1000 r.p.m. and incorporate in the cylinder design the Lister patented combustion chamber. A smaller 14 B.H.P. engine complete with reverse gear is on view, and also an auxiliary set shown in Fig. 80, which comprises a 7 B.H.P. single-cylinder Lister engine coupled on the one side to a Hamworthy 10 cubic feet 30 lb. per square inch air compressor and on the other to a 1·5-kW 100-volt Lister generator and a service pump. The whole line of machines is designed to run at the standard engine speed of 1000 r.p.m.

GLENIFFER ENGINES, LTD.

Since Gleniffer high-speed oil engines were first shown at the Shipping, Engineering and Machinery Exhibition of 1929 considerable numbers have been installed in all kinds of marine craft, both for main propelling and auxiliary work. The engines shown this year incorporate improvements in details of design which have been made as a result of the experience gained, but the three outstanding features of the Gleniffer engine remain—the air motor method of starting, the automatic lubrication system, and finally its high flexibility, which is demonstrated on the stand by the running of a six-cylinder 120 B.H.P. engine. The firm is also exhibiting one of its standard reverse gears. The normal range of Gleniffer engines is from 45 to 160 B.H.P. at speeds varying from 700 to 900 r.p.m., but this has been extended by a new type of engine, illustrated in to-day's Supplement, Fig. XVII. It has an output of 12 B.H.P. per cylinder and will be constructed in two, three, four, six, and eight-cylinder sizes, of which the three-cylinder 36 B.H.P. is being exhibited on the stand.

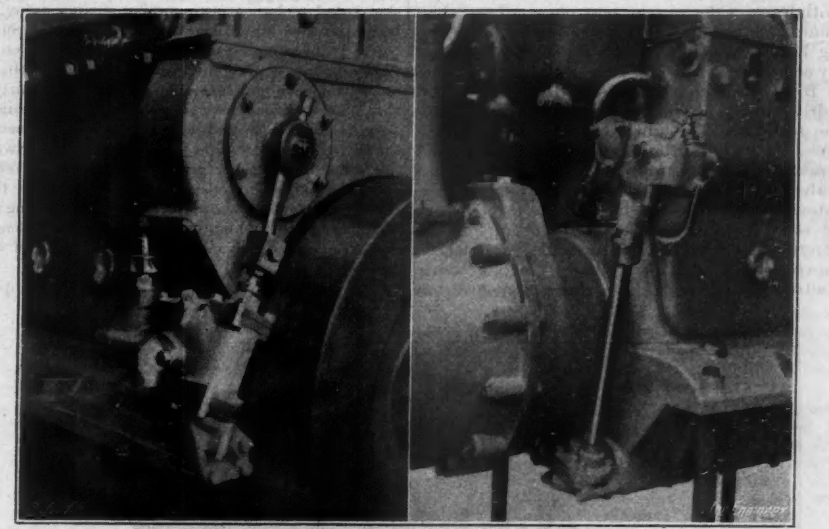


FIG. 81—ARRANGEMENT OF CIRCULATING WATER AND LUBRICATING OIL PUMP DRIVES—GLENIFFER

The design, while following closely that of the earlier engine, incorporates new features. We may refer to the neat V form of air starting motor, shown to the left of our illustration, near to the fly-wheel. Other interesting features, shown in Fig. 81, are the circulating plunger type water pump driven from an excentric on the end of the cam shaft, and the drive to the submerged oil pump which supplies the main bearings and gudgeon pins. A relief valve fitted to the system also furnishes an oil feed to the cam boxes and through the hollow cam shaft to the timing chain. A neat form of governor control with a hand speed control lever is fitted. A pleasing feature is the completely jacketted exhaust manifold and a water injection silencer, which is fitted to the after end of the engine.

THE ELECTRO-MECHANICAL BRAKE COMPANY, LTD.

We illustrate in to-day's Supplement, Fig. XVIII., the three-cylinder, 40 B.H.P. marine oil engine of the Wiseman type fitted with reduction and reversing gear, and exhibited as a running unit by the Electro-Mechanical Brake Company, Ltd., of Moor-street, West Bromwich. It has a bore of 4in., a stroke of 6in., and a full load running speed of 1500 r.p.m. A feature of the engine is the patented design of cylinder head —see Fig. 82—and combustion chamber, which has been designed to give the air charge a high rotational velocity, both on the compression and firing strokes, thereby ensuring not only complete combustion, but also making the engine exceptionally easy to start up by hand from cold. The easy starting of the engine and its smooth running is demonstrated on the stand. The air charge is drawn from the cylinder covers, which, it is claimed, obviates the disagreeable odour produced by any stray oil on the hot cylinder heads. Forced feed lubrication to all parts of the engine is provided, and a governor, adjustable to any speed while running, is incorporated in the design, while an independent control allows the engine to be instantly stopped without affecting the normal governor control. A low-pressure fuel pump is fitted to serve the injection pump, which is of the Bosch pattern, thereby allowing the fuel tanks to be fitted in any convenient position. The engine is constructed in one, two, and three-cylinder units, with a speed range of 200 to 1500 r.p.m., and normal rating of 12 to 13 B.H.P. per cylinder.

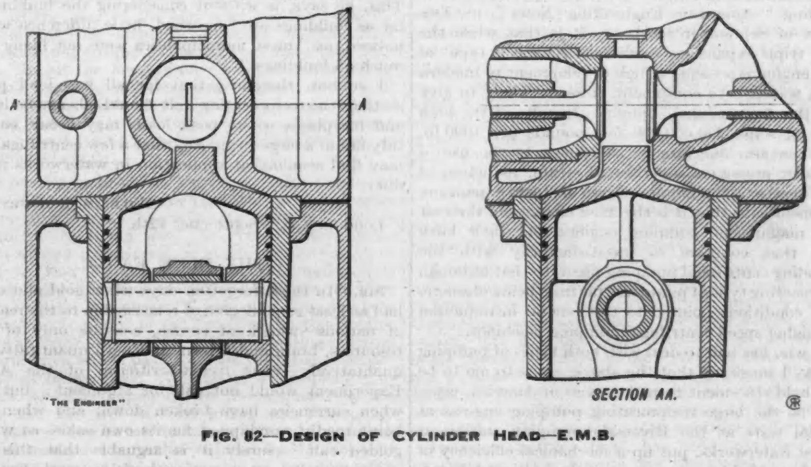


FIG. 82—DESIGN OF CYLINDER HEAD—E.M.B.

DAVEY PAXMAN AND CO. (COLCHESTER), LTD.

The largest engine on the stand of Davey Paxman and Co. (Colchester), Ltd., of Colchester, and Aldwych House, London, W.C.2, is the 300 B.H.P., six-cylinder, airless injection engine coupled to a 200 kW generator running at a speed of 600 r.p.m., which we illustrate in Fig. 83, while a new engine is the four-cylinder, 100 B.H.P. direct reversing engine which runs at 750 r.p.m. A view of this unit in course of completion in the makers' works is given in to-day's Supplement, Fig. XIX. In general construction, both units are similar, a monobloc type cylinder casing being used with through-going bolts to the bed-plate, which take the combustion stresses. Large inspection doors form a feature of the design, and they are so dimensioned that after freeing the big end, the piston and connecting-rod can be lowered into the crank pit and withdrawn sideways in one piece. Less than two minutes is required for this operation after the bearing has been undone and the piston can be as quickly and easily replaced. There are two cam shafts driven from the crank shaft by a Renold enclosed chain drive, and these, in turn, drive the fuel pumps and the governor. The lubricating system includes a pressure supply to the running parts with a separate low-pressure pump for supplying oil to the cam shaft and valve gear from the cam shaft troughs. The generator unit is controlled by a single lever, while, in the case of the marine type reversing engine, manœuvring is carried out by a single hand wheel, the movement of which in either direction starts and controls the speed of the engine under governor control as may be required. The gear is simple in design, and is claimed to be accident-proof, a feature being that there is no moving of the cam shafts with the cams, rockers, &c. The arrangement adopted is particularly suited for control from the bridge if this is desired. The marine engine, as our illustration shows, is complete with its service pumps and starting air compressor, or dynamo, and a thrust bearing is incorporated in the design. The 300 B.H.P. engine has a bore of 9in. and a stroke of 12in., while the 100 B.H.P. reversing engine has a cylinder bore of 6½in. and a stroke of 10in. The company manufactures a range of high-duty engines from 50 to 1500 B.H.P. for industrial and marine use, and for locomotive work.

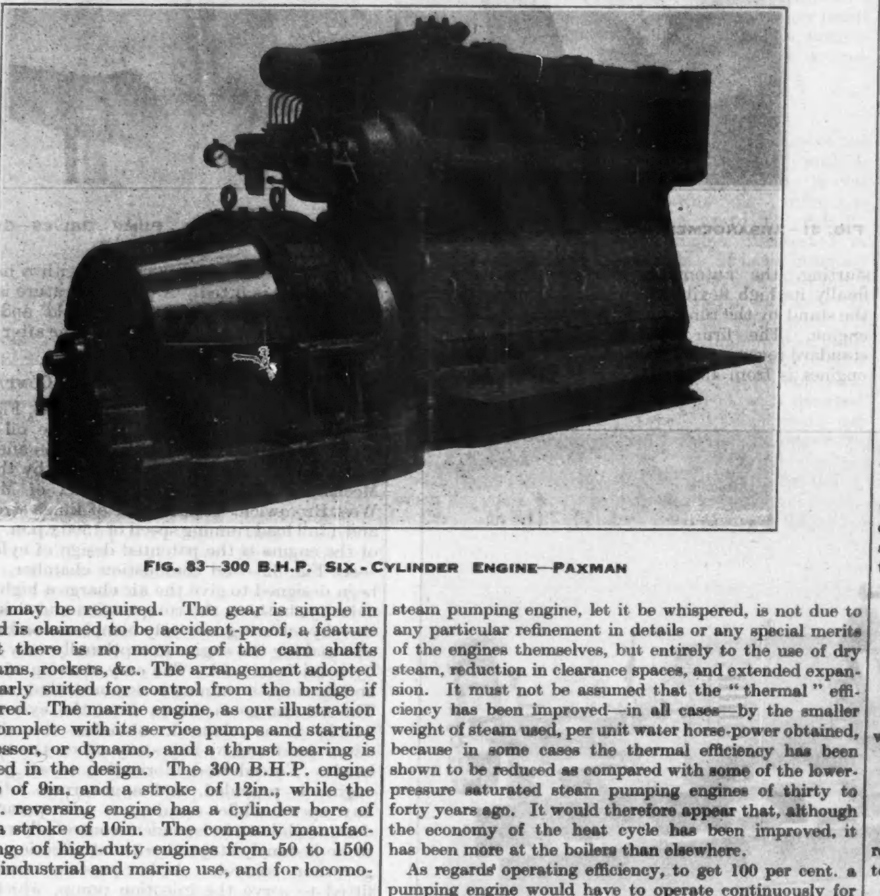


FIG. 83—300 B.H.P. SIX-CYLINDER ENGINE—PAXMAN

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opir ions of our correspondents.)

WATERWORKS PUMPING MACHINERY.

SIR,—A rather significant statement appeared under the heading "American Engineering News" in THE ENGINEER of September 1st last. It is that while the inverted triple-expansion crank-and-fly-wheel type of pumping engine represents a high development in modern American waterworks equipment, it seems likely to give place to the "centrifugal" pump. In spite of the high efficiency of some 200,000,000 foot-pounds per 1000 lb. of "dry" steam, due largely, of course, to the use of higher boiler pressures, superheated steam, reduction of clearance spaces, and a greater degree of steam expansion, the statement says that it is the fixed charges on the cost of these magnificent pumping engines and their lofty buildings that compare so unsatisfactorily with the corresponding centrifugal pumping plant, so that although the reciprocating type of pump was far from being obsolete, economic conditions pointed to the general introduction of these higher speed centrifugal pumping machines.

As one who has had to deal with both types of pumping machinery, I must say that the above seems to me to be a pretty bold statement to make, even in America, especially so as the large reciprocating pumping engines at the official tests at the Riverside pumping station at Milwaukee waterworks, put up a mechanical efficiency of no less than 98·14 per cent., namely indicated horse-power in the steam cylinders of (by cards) 1121·88, and "water horse-power" of 1101·01. Surely such a splendid performance can defy the best endeavours of any type of centrifugal pumping plant. It is true that the steam turbine can be made very efficient when using very high temperature steam, and that in very large powers—much above that essential or desired for waterworks pumping—it is also comparatively more efficient than a reciprocating unit may be, but, even then, it surely cannot be assumed that the reliability and all round variable head pumping efficiency can be so good as that attained by the slow-speed "ram pump" for the commercial purposes of moving water. As an example of the long life which these slow-speed reciprocating pumping engines enjoy, it may be stated that Milwaukee City purchased in 1891 for its North Point pumping station an 18,000,000-gallon vertical triple-expansion pumping engine, which held the world's record for economy for some time. After thirty years' continuous service it was thoroughly overhauled at a very nominal cost and was then placed in service for another thirty-year run. During the forty-two years' operation it has never given the waterworks officials or their staff the least anxiety, and I do not believe there has ever been a breakdown, and this type of pumping machine has maintained its high pumping duty over a long period of years, and with a most remarkable low cost of maintenance.

The improved economy in the modern reciprocating steam pumping engine, let it be whispered, is not due to any particular refinement in details or any special merits of the engines themselves, but entirely to the use of dry steam, reduction in clearance spaces, and extended expansion. It must not be assumed that the "thermal" efficiency has been improved—in all cases—by the smaller weight of steam used, per unit water horse-power obtained, because in some cases the thermal efficiency has been shown to be reduced as compared with some of the lower-pressure saturated steam pumping engines of thirty to forty years ago. It would therefore appear that, although the economy of the heat cycle has been improved, it has been more at the boilers than elsewhere.

As regards operating efficiency, to get 100 per cent. a pumping engine would have to operate continuously for no less than 8760 hours, *i.e.*, for the complete year. On this point an eminent waterworks engineer in Chicago sums up the position in America pretty well, I respectfully submit. He says: "A careful study of the different types of pumping units has been made, and it has been found that if the units are to run less than 3500 hours per year, or only 4¾ months out of the twelve, the centrifugal pump would appear in most cases to be the more economical. But if the units are to run more than 3500 hours, then the reciprocating unit, in the form of the triple-expansion pumping engine, would be the most economical." This, he says, is without considering the buildings. As far as buildings are concerned, little difference would be noticed, as "most municipalities were not likely to save much on buildings."

I submit, therefore, that for all base-load pumping stations the reciprocating unit should always be installed, and for places where peak loads may occur, such as a tidy fire in a large town, &c., that a few centrifugal pumps may find economical application in waterworks pumping duty.

WILLIAM P. DURTNALL.

London, S.E.5, September 12th.

THE BLUE EAGLE.

SIR,—In those forgotten days when gold and currency had at least some degree of relationship to the real wealth of nations—which, of course, consists only of natural resources, brain and brawn, and both quantitatively and qualitatively—your recent criticism of the American Experiment would not call for argument; but to-day, when currencies have broken down, and when gold is being madly worshipped for its own sake—as was "the golden calf"—surely it is arguable that this gallant experiment to get a nation back to work has a very logical basis, and one that the British Empire may well find it necessary to follow?

The psycho-analyst will tell us that the eagerness with which a young child will extend its hand for a proffered coin, the smile on our bank manager's face if we pay in a big cheque, and the reluctance of the Middle West farmer to forego war debts, are all symptomatic of an atavistic instinct which we, I suggest, are only beginning to realise, no longer holds true. Money, it is obvious, will always be needed, but it must bear some relationship to the commodities of which it is symbolic, and to re-establish true values what better way can there be for any great nation than to stabilise her own currency within her own borders, and trust to absorb her own products in the development of her own interests?

This, it seems to me, is what America is trying to achieve, and comparing for a moment the British Empire as a whole with the United States as a whole, it is interesting to consider would, or would not, our position be bettered if we cut adrift from Europe, stabilised the pound within the Empire and proceeded to "cultivate our own garden" by every means within our power? One knows the answer of the International group in advance, but they are not Empire builders, but Empire dissipators, and we cannot afford longer to be led by them. There is only one Utopia; a land of work and progress for all. America, with fewer facilities to achieve success, has gallantly begun to act on this assumption; by following her example we may find our own salvation, but by joining forces with her we could jointly command the world. I suggest events may show that stranger things have happened in history! S. P. CHRISTIE.

London, S.W.7, September 14th.

DIVING FOR YOUNG ENGINEERS.

SIR,—The good advice given on the above subject in your last issue, is of much interest to those who are, or have been, engaged on this class of work. A matter of importance, however, seems to me to have been overlooked. It is, that no amount of training on under-water work is of much assistance to the worker or inspector of work unless accompanied by the natural gift that all must possess to be efficient. The gift of touch is a rare one. The diver seldom sees his work; he feels it.

A point I would like to see pressed home and one that would help the profession, "the black sheep," the contractor, and those responsible for difficult and oftentimes dangerous work, is—That no contractor should be held responsible for conditions outside his control, viz., bad sea conditions, whereby as much as 75 per cent. of the contract time is lost. Yet penalties are imposed on this account for non-completion of work on contract time. Such a penalty cannot be in the interest of the work.

Again, the contractor is all too often blamed for the unreliable information he receives from plans, soundings, etc., his prices having been based on quite different information. Yet he is called upon by rigid contract terms to foot the bill. That is gambling, not engineering.

The moral is:—

(1) Give Reliable information on which to base prices.

(2) Add a compensation clause in lieu thereof.

(3) Impose no penalties for conditions outside the contractor's control.

(4) Stop gambling and stick to engineering.

There will then be no black sheep to charge on occasion with bad constructional under-water work.

London, S.W.14, September 19th. W. T. G.

COLLIERY ELECTRICIANS.

SIR,—With reference to your editorial comment on the report of the Electrical Inspector of Mines, I would like to add a few facts which may be of interest to your readers.

In the first place, colliery electricians and other craftsmen suffer from an initial disadvantage, in that in too many instances their apprenticeship is not conducted on properly organised lines. The training is very haphazard, and the apprentice is too often left to his own devices to teach himself as he best can. No doubt a few large firms have a model system of training, with their own schools, &c., but these are in the minority.

In the second place, the wages paid to colliery craftsmen are ridiculously low. For example, the county rate of pay in Durham is 6s. 7·2d. per shift, while in Northumberland the county rate is 6s. 9½d. per shift. These rates are also approximately the minimum wage rates for datal hands and all classes of general labour!

To be perfectly candid, as far as competence is concerned, there are isolated instances of craftsmen who are somewhat lacking in technical knowledge. However, in spite of the obvious disadvantages, a large number of craftsmen hold technical certificates and not a few have university and professional qualifications.

Whilst on the subject of certifications, I think it should be made compulsory that colliery engineers, assistant engineers, and others holding responsible positions should hold a recognised qualification, such as membership of one of the major institutions.

September 16th. A.M.I. MECH. E.

MACCLESFIELD WATER SUPPLY.—At 10 a.m., Saturday, September 9th, Mather and Platt, Ltd., Park Works, Manchester 10, received an order from the Macclesfield Corporation for an emergency pumping plant, and within ten working hours had installed a 2in./3in. electrically driven "Medivane" pump of 3400 gallons per hour at 100ft. head capacity, driven by a 7½ H.P. squirrel-cage induction motor, complete with necessary control gear valves, and suction and delivery piping. The water supply has been obtained by erecting a dam across the Pyegreave stream at Langley, which is fed by four springs on the hillside, and in the event of rain and an increase in the water supply from the springs the pump is capable of delivering a larger output. The set was despatched from the works at twelve noon on Monday, September 11th, and erected on site the same afternoon. As a result of this quick work and organisation Macclesfield water supply is now increased by approximately 70,000 gallons per day.

Railway and Road Matters.

An express train with seven coaches achieved during the evening of September 19th what is believed to be the fastest run ever made on the L.M.S. Railway. Hauled by the "Royal Scot" class engine "Comet," it covered the 94 miles from Coventry to Euston in 75 min., an average of 74·8 miles an hour. A speed of 92 miles an hour was twice reached during the journey.

The works of the Stockton and Darlington Railway—opened on September 27th, 1825—were at Shildon in South Durham, and there Timothy Hackworth had his, headquarters. The Railway Institute at Shildon was built soon afterwards, and the centenary of its establishment is about to be celebrated under the patronage and with the support of the chairman, directors, and chief officers of the London and North-Eastern Railway.

The increases, week by week, in the passenger traffic returns, must not, as we have before advised, be regarded as signs of improved trade; they are due mainly to the remarkably fine weather and the introduction of "summer" return tickets. A better sign is to be found in the three larger groups reporting increases, for the thirty-sixth week, in both merchandise and coal traffic. The Southern now reports an increase for the year to date, and the losses on the other companies have been much reduced.

The L.M.S. Railway Company has placed with a Middlesbrough firm a contract for the reconstruction of a bridge carrying the Acton Branch over Acton-lane, Willesden, N.W. The allocation of this contract represents a further stage of the scheme which the L.M.S. have in hand for strengthening the bridges on the Cricklewood to Acton branch in order to carry larger locomotives. Two bridges, including one over the Edgware-road at Cricklewood, have already been rebuilt, while the reconstruction of another, over Neasden-lane, is now in progress.

To the surprise of the railway people present and others interested, the coroner's inquest, arising out of the Little Salkeld collision of July 10th, was, on September 12th, further adjourned until October 16th, because the civil authorities had not completed their inquiries. In this case an express passenger train ran past the signals and collided with a goods train, the driver of which received fatal injuries. As there were, we believe, extenuating circumstances in favour of the driver of the express, the further postponement of the opportunity to make all the facts known is to be regretted.

An important improvement scheme is being carried out by the L.M.S. Railway at the motive power depôt at Nuneaton, where a large number of engines are stationed for working passenger and freight services in the Trent Valley area. New equipment which is being installed includes a mechanical coaling plant to replace the present coaling stage, and a mechanical ash-lifting plant, which will deliver locomotive ashes direct from the ash pit into wagons for disposal. Improvements are also being made to the general lay-out of the shed yard, which will reduce the amount of shunting to be done by engines.

Three stations on the Underground have been greatly improved. One is the combination of the Central London British Museum Station with the Holborn of the Piccadilly Tube; the next is the new Green Park Station near the Ritz Hotel, which will displace Dover-street Station; the third is the new subway and escalators that will join the Monument Station on the Inner Circle with the Bank Station of the Central London. The second and third of these were opened on September 18th. The improvements at Knightsbridge and Chancery-lane are hoped to be finished by the end of the year.

The misfortunes of the Great Orme Tramway, which followed the fatal accident on August 23rd of last year, have more than once been referred to in our pages. That attention on our part has been due to the fact that after the line had been inspected and passed by the Board of Trade an automatic emergency brake was withdrawn, and therefore was not available when the drawbar broke. After the accident the line was closed, and the Ministry of Transport will not permit it to be reopened until its requirements have been complied with. Meanwhile, the property has passed into the hands of a receiver, as a consequence of failure to pay damages that had been awarded for personal injury. We mention the subject again because at a meeting of the creditors it was stated that efforts were being made to comply with the requirements of the Ministry; whilst not completely successful, they had given indications of being on the right lines. It was also revealed that the tramway company has taken action against the maker of the drawbar, but the case has not been brought to trial.

The passing of the Metropolitan Railway prompts the observation that that company was, in many directions, a pioneer in railway signalling. When, for instance, its line between Praed-street and Aldgate was equipped with automatic signals, the electro-pneumatic system of operation, used on the Metropolitan District and the tube railways, was not employed, but the all-electric method, as since installed on all other lines, except those just named, was used. In 1911 locking bars at facing points were dispensed with and the points held instead by a length of track circuit—a practice that is now universal on all railways. In the same year automatic semaphore signals, with arms moving in the upper quadrant, were fixed between Finchley-road and Neasden, and in 1912 a great economy in men was effected by providing fog-lights in place of fog-signalmen. In 1926 the first long-distance point mechanism was installed on the east side of Euston-square Station, wherein the points were worked from King's Cross box, 660 yards away. The locking frame at Wembley Park, wherein the interlocking is actuated electrically, was the first such frame outside the Southern Railway—where it was originally introduced—and from the same box is actuated the first instance of centralised traffic control outside North America. That actuates the points and signals at Stanmore, 4½ miles away. Both these works were opened in 1932, and since then the two mechanical locking frames at Farringdon-street and Aldersgate respectively, have been electrically interlocked.

Notes and Memoranda.

The Pelton wheels in the Niederenbach hydro-electric station, in Switzerland, work under a net head of 3280ft. The total static head is 3560ft. There are two units, each of which is rated at 11,450 H.P., and runs at 750 r.p.m. They drive 11,000 kVA, 8800-volt generators. Each turbine has only one bearing, and is directly coupled to a two-bearing generator.

According to a paper recently prepared for the Canadian Institute of Mining and Metallurgy by Ralph H. Cleland, of the Ontario Department of Mines, rock temperatures rise by 1 deg. Fah. for each 220ft. in depth in the Porcupine gold mines, and for each 160ft. at Kirkland Lake and Sudbury. Canadian mines can, he estimates, be carried to a depth of 6500ft. or more without difficulty.

Apparently, according to the *Rangoon Times*, one of the chief causes of derailments on Indian railways is the malicious removal of fish-plates. To stop this practice Mr. J. A. Guest has invented the Guest-Avatt fish bolt. From the brief description given, it appears that the bolt, after being passed through the fish-plates and rail is bent down and passed through a hole in the sleeper. The nut is screwed on beneath, where it is not easily accessible.

An electrolytic method for the purification of mercury was recently described by Professor E. Newbery and Mr. S. M. Naude, of Cape Town University, to a meeting of the American Electro-chemical Society. A mercurous perchlorate electrolyte is used with a cathode of pure mercury, an E.M.F. of 0·5 volt, and a current density of about 1 amp./dm.^{2} The chief difficulty encountered lies in the formation of crusts of solid salt over the exposed surface of the anode. Spectroscopic examination of the product indicates that a high standard of purity is obtained by this process.

The fact that upon exposure to light a change in the electrical resistance develops in certain thallium compounds has, according to an article in the *Chemical Trade Journal* by Dr. J. C. Munch, led to a practical application. The "thalofide cell" contains thallium oxysulphide as the effective agent. In preparing the thalofide cell, thallium oxysulphide is fused on a quartz plate, and mounted in an evacuated bulb to prevent oxidation. The most sensitive bridges of this material show a change of 50 per cent. in electrical resistance for an illumination less than 1 metre-candle. The dark resistance varies from 5 to 500 megohms, and these bridges have a large temperature coefficient. Their response is essentially linear over the entire range; 0·06ft. candles of light will be detected. These thalofide cells are very rapid, the current increase normally occurring in less than one one-hundredth of a second, and showing a maximum action at a wave-length of 1·05 μ.

Straight cylindrical work without heads can, says the *Iron Age*, be centreless ground in any length up to approximately 24ft. by the through-feed method. This work, whether it is short or long, should be straight before passing through the machine. It is necessary that before centreless grinding long bars be machine straightened, or at least straightened to the same degree as obtained by machine straightening. If the long bars are not straight before grinding, they will whip both on the entering and leaving sides of the wheels and the work will make contact with the corners of the grinding wheel, thus causing spiral marks to appear on the ground surface of the bar. Long bars up to 4in. in diameter by 24ft. long have been successfully ground by the centreless method. When grinding bars of such length, it is necessary, of course, to provide auxiliary supports at both front and rear of the machine, in order properly to support and align the bar before it enters and after it leaves the grinding cut.

Nitrogen, when uniformly alloyed in the chromium and the nickel-chromium steels, and in amounts of the order of 0·20 to 0·30 per cent., has been found to impart such beneficial effects that a broadening of the use of these steels is regarded as the natural outcome. The researches bearing on the subject in the Union Carbide Laboratories, Long Island City, New York, are described in the *Iron Age* by R. Franks. Castings and also the wrought steels, including those of the stainless class, respond to the addition of the nitrogen. In the case of the high-chromium alloy castings, a product is obtained that withstands abuse without cracking, suggesting its application in pump impeller parts having great differences in cross section. In the case of the chromium-nickel steels, the introduction of the nitrogen improves machinability and provides non-magnetic castings of relatively high strength. In all the low-carbon classes of these alloys, considerable ductility and toughness is added and a non-magnetic wrought material of high yield point, machinability, and resistance to staining is obtained. The nitrogen is added in the form of high-nitrogen ferrochromium, as explained in the article.

A new process patented for the preservative treatment of timber to be used for telegraph poles or railway sleepers consists in injecting an impregnating medium into the sap stream of the living tree. The usual impregnating media are carried imperfectly, if at all, by the sap, but, according to Max Knopff, writing in *Telegraphen- und Fernsprech-Technik*, arsenious acid, arsenic acid, or their easily soluble salts, can readily be conveyed from the base of the trunk to the ends of the branches by this means. Bore-holes in the trunk are filled with the treating material in the form of a solid paste, or concentrated solution. The openings being closed by plugs of wood, plaster, or clay, the arsenious compounds are disseminated by the sap flow, and the tree is soon killed and thoroughly impregnated; it can be left to season before being felled. The cost of treatment is further reduced by the fact that the arsenious compounds are capable of carrying with them other and cheaper impregnating materials which cannot be carried by the sap alone. Satisfactory results are said to have been obtained with a mixture of seventy-five parts arsenic acid with twenty-five parts sodium fluoride, and with a mixture of sodium arsenite and benzoate in equal parts.

Miscellanea.

A factory for the production of titanium pigments is being put up at Billingham-on-Tees.

It is reported that a very extensive graphite deposit has been discovered in the neighbourhood of Pelion, Greece.

Distilleries for the manufacture of industrial alcohol will shortly be established in the Irish Free State under the control of the Government.

It is proposed to construct a hydro-electric power plant, with a capacity of 750,000 horse-power, at Orsova, where the Danube crosses the Rumania-Yugoslovak border.

A new hydro-electric plant is to be constructed on the Nagara River in Japan. The output is to be about 40,000 kW and the costs are estimated at £460,000 inclusive of transmission lines.

Mining work is proceeding at full speed in the territory of the Balachtinsky gold-bearing region of Western Siberia. Mines will soon be ready for exploitation. A town for the workmen consisting of 500 flats and an electrostation are under construction.

Draft rules for the port of Vizagapatam have been gazetted. It is announced that the new Vizagapatam harbour will be opened to ships of 27ft. draught in October or November, and that it will be formally opened, perhaps, by the Viceroy of India, in January.

One of the biggest blasts in the history of quarrying, according to an account in the *Iron and Coal Trades Review*, took place on Wednesday at Raynes Quarry, Llysfaen, Colwyn Bay, when between 60,000 and 70,000 tons of limestone were dislodged. It had taken the borers weeks to get ready for the blast. The quarries are now owned by Imperial Chemical Industries, Ltd.

Following a series of trials between Toulouse and Saité Foy de Peyrolieres, the Compagnié des Chemins de Fer du Sud-Ouest Français has decided to adapt its system to accumulator traction, and an order has consequently been placed for a number of electric locomotives weighing 34 tons each, capable of attaining a speed of 37½ m.p.h. Each engine will be fitted with four motors developing 50 H.P. each at 800 r.p.m., and with power at 125 V supplied by an 800-Ah, 135-cell battery.

The Christmas Island Phosphate Company has for some time past maintained a small wireless station, which is being extended and modernised by the provision of two Marconi stations for direct communication with Singapore and with distant ships. The link with Singapore is by short wave, utilising a transmitter covering the waveband of 20 m. to 100 m., with a power to the aerial of 250 W when operating continuous wave telegraphy, for which it is particularly designed. For working with ships on medium wave lengths, a special 200-W transmitter has been supplied. Christmas Island is 800 miles south of Singapore in the Indian Ocean.

The Dominion Bureau of Statistics at Ottawa reports that during the first six months of this year, the output of primary steel totalled 130,464 tons, as compared with 180,488 tons for the corresponding half of 1932, and with 461,877 tons for the first half of 1931. Production of ferro-alloys during the six months totalled 6078 tons, as compared with 8759 tons during the corresponding period a year ago. On June 26th, a 350-ton blast-furnace went into operation at Port Colborne, Ontario, and a 55-ton furnace was blown in at Sydney, Nova Scotia, on June 28th. Pig iron production in June totalled 857 long tons, being the first pig iron made in Canada this year since February 14th.

It is probable, says Mr. Ludlow, of the American Institute of Architects, that skyscrapers will not be built again for many a long day, perhaps never; one reason being that the exodus of population from the big cities of America has already begun, and the congestion in cities, of which the skyscraper is a product, is slowly yielding. This is an interesting theory, and we hope that it has some foundation in fact. Under present conditions in large cities, cost of living is increasing due to high rentals, and far too much time is wasted daily in transportation. Serious traffic problems are caused by the people employed in these high buildings, all entering or leaving the buildings about the same time. Abandonment of the skyscraper would eliminate many problems now facing town-planning engineers.

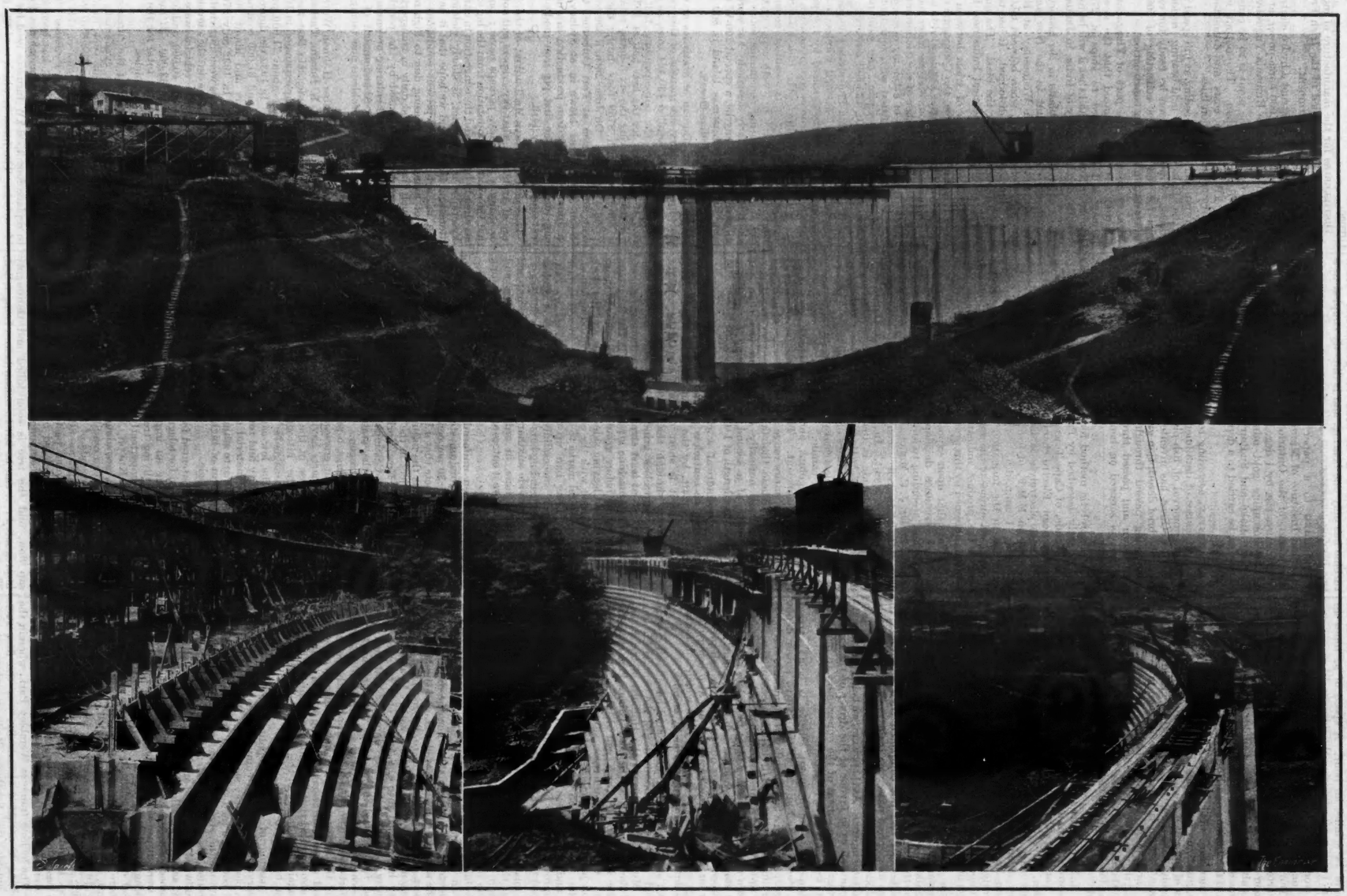
Speaking at the Humber-Hillman Works at Coventry, on Tuesday last, Dr. E. L. Burgin, Parliamentary Secretary to the Board of Trade, said that the British motor industry began its post-war expansion in 1923, and in that year manufacturers made about 71,000 private cars and 23,000 commercial cars. In 1932 the figures had increased to 171,000 private cars and 61,000 commercial cars. In 1925, 41,000 private cars and about 6000 commercial vehicles were imported. In 1932 only 2762 private cars and 310 commercial vehicles were imported. Those figures gave ground for confidence in the development of the industry. In 1924, 15,000 vehicles were exported. In 1932 that figure had become 40,000, and for the first eight months of this year it was 33,000. If manufacture continued at the same rate, the total for the year would be nearer 50,000 than 40,000 vehicles.

Although the majority of the furnaces used for the production of calcium carbide, cyanamide, and iron alloys in France are of the single-phase type, furnaces employing three-phase power are, says the *Electrical Review*, gradually coming into use, two large ones of this variety having lately been constructed in the Pyrénées. The first, which has a capacity of 11,000 kW, has been installed at the works at Marignac of the Société des Produits Azotés to replace four 3500-kW furnaces used for the production of carbide. The furnace, which is of the Soderberg three continuous electrode type, has been developed in conjunction with the Société des Electrodes de la Savoie. The second furnace, which has been installed at the Lannemezan works of the Société des Produits Azotés, has a capacity of 12,000 kW, and is also used for carbide production. The electrodes in this case are, however, not continuous, but are similar to those used in Germany by the Stickstoff Company.

CONSTRUCTION OF THE RYBURN DAM

C. CLEMESHA SMITH, M. INST. C.E., WAKEFIELD, ENGINEER

(For description see page 287.)



ABOVE:—GENERAL VIEW OF THE DAM NEARING COMPLETION
BELOW:—VIEWS OF THE DAM IN AUGUST, 1930, AND APRIL AND MAY, 1932

MARINE PROPULSION AND GENERATOR SETS AT OLYMPIA

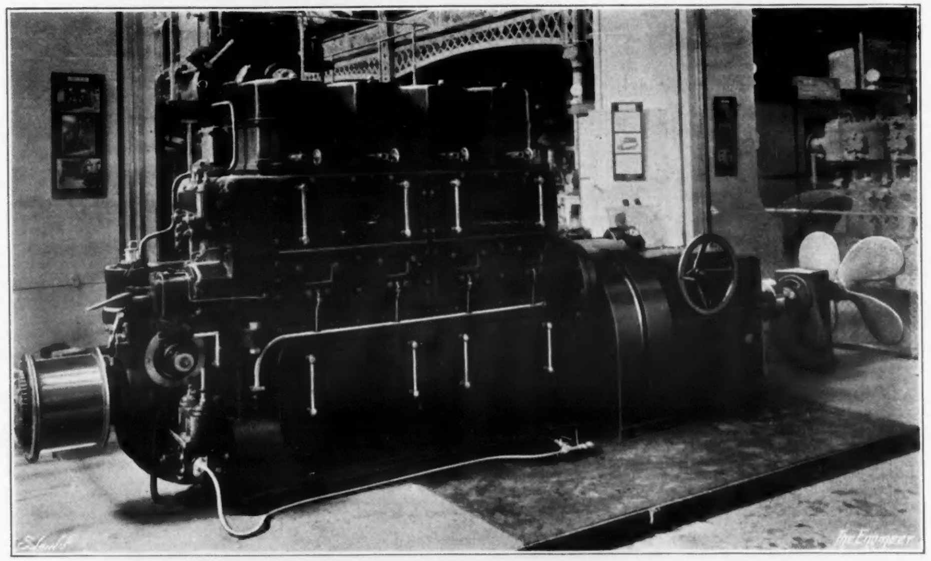

Swain Sc
The Engineer

FIG. I.—134 B.H.P. FOUR-CYLINDER MARINE OIL ENGINE—ALLEN

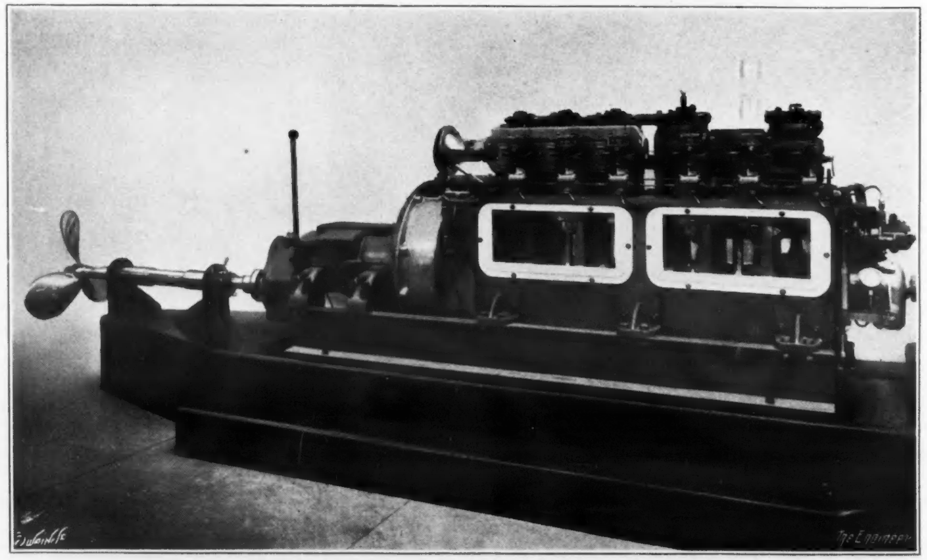

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FIG. II.—120 B.H.P. SIX-CYLINDER SLEEVE-VALVE MARINE OIL ENGINE—MIRRLEES

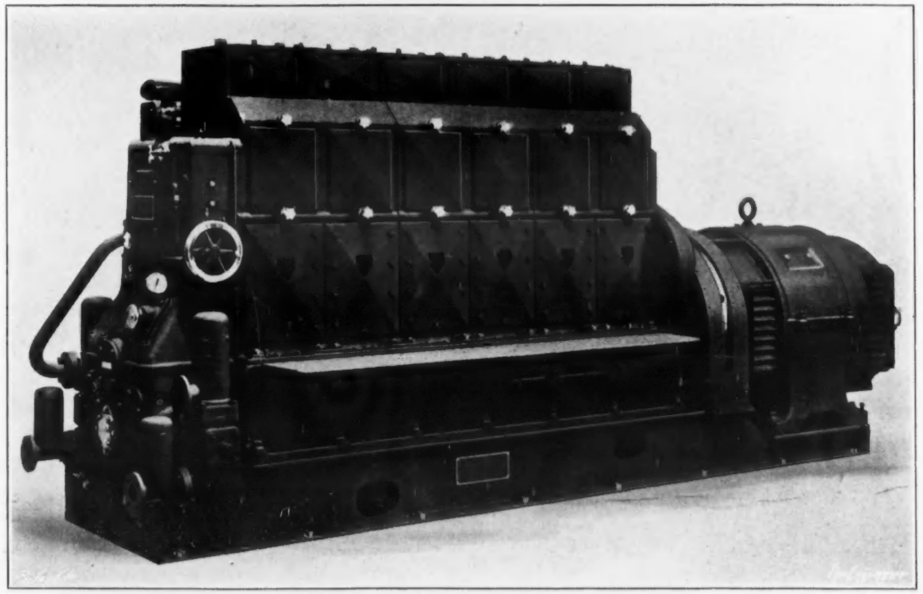

FIG. III.—200 B.H.P. SIX-CYLINDER OIL ENGINE GENERATOR SET—BELLISS AND MORCOM

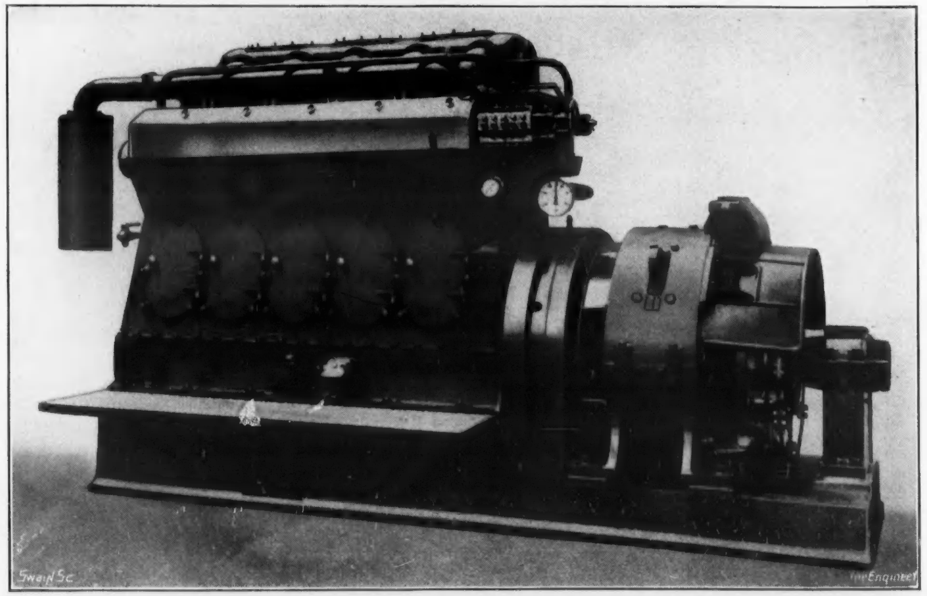
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FIG. IV.—150 B.H.P. FIVE-CYLINDER OIL ENGINE GENERATOR SET—RUSTON AND HORNSBY

AIR COMPRESSORS AND GAS COMPRESSORS AT OLYMPIA

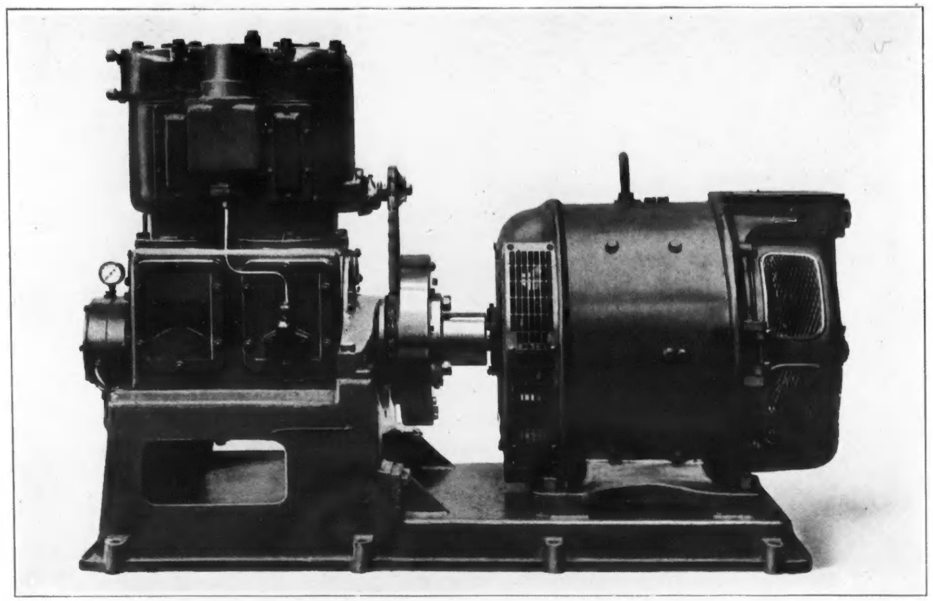

Fig. V.—Two-Cylinder Motor-Driven Air Compressor—Broom and Wade

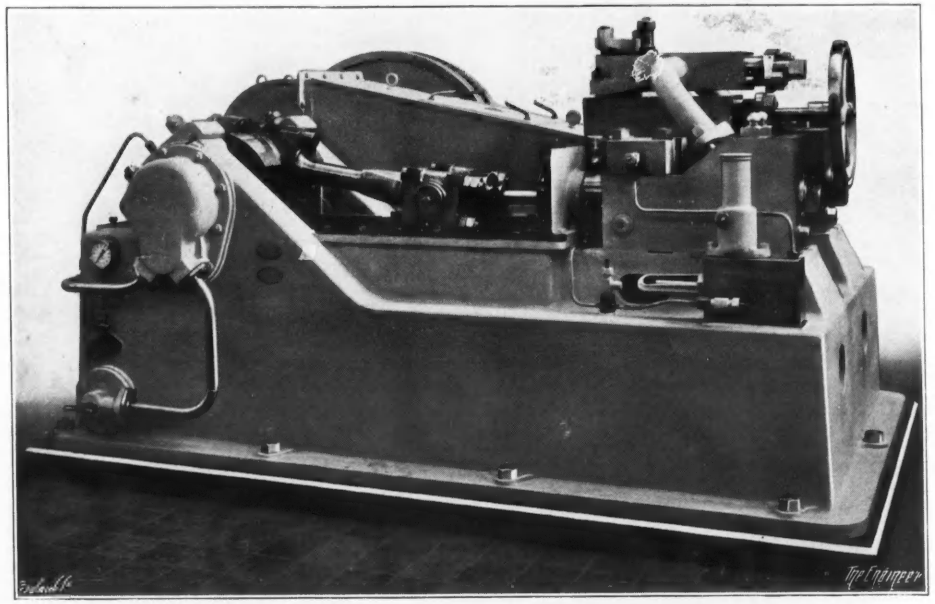

Fig. VI.—Horizontal Twin Marine Type CO_2 Compressor—Hall

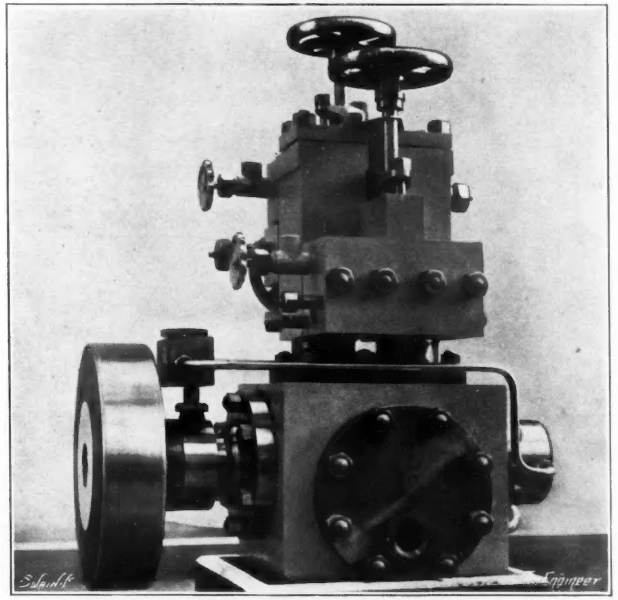

Fig. VII.—Vertical CO_2 Compressor for Ship Use—Hall

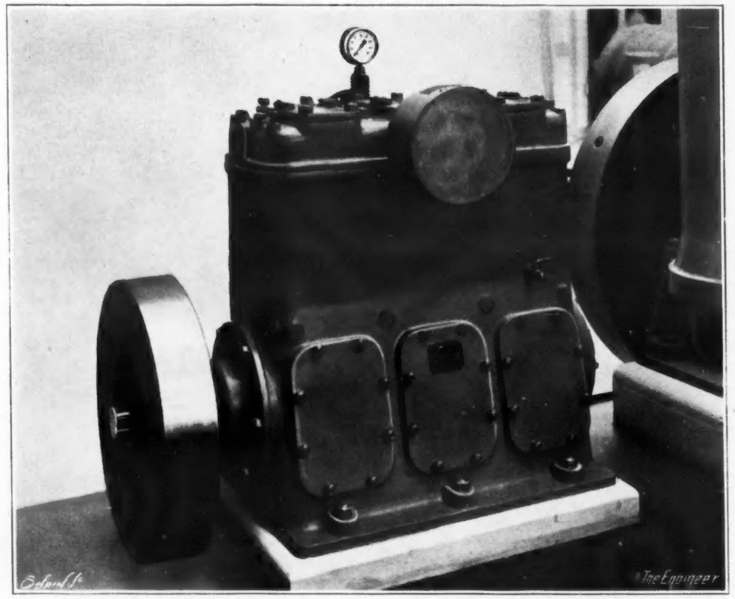

Fig. VIII.—Three-Cylinder Air Compressor—Reavell

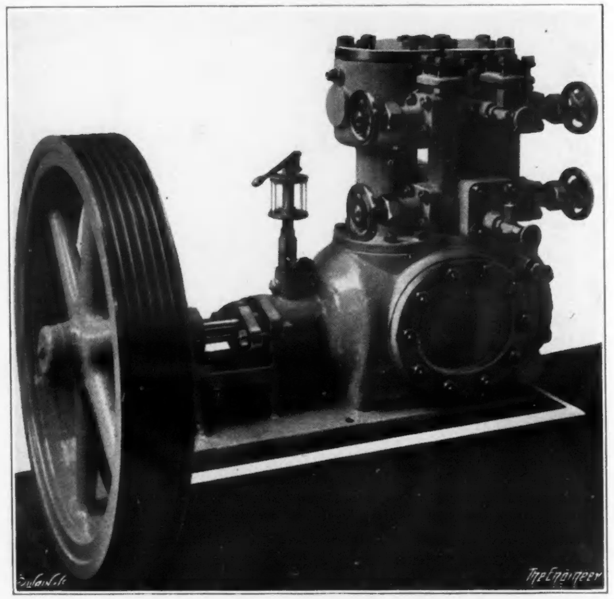

Fig. IX.—Twin-Cylinder NH_3 Compressor—Hall

TURBO-GENERATOR, PUMPS, AND COMPRESSORS AT OLYMPIA

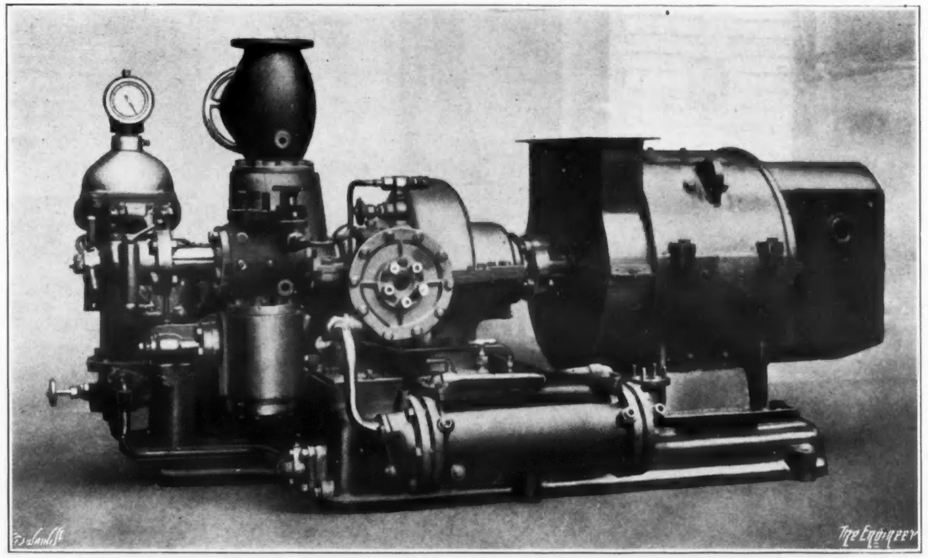

FIG. X.—50-kW GEARED MARINE TURBO-GENERATOR SET—ALLEN

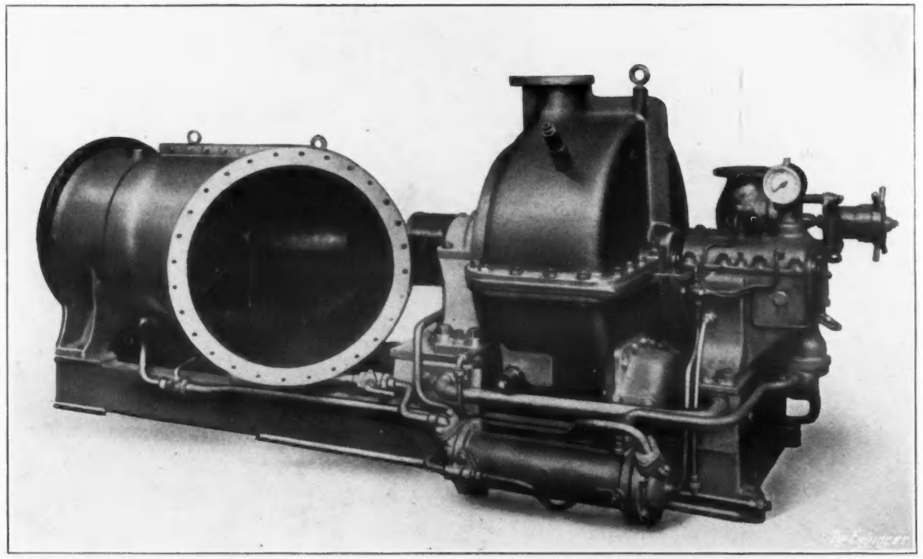

FIG. XI.—ALLEN-GILL TURBINE-DRIVEN AXIAL FLOW CIRCULATING PUMP—ALLEN

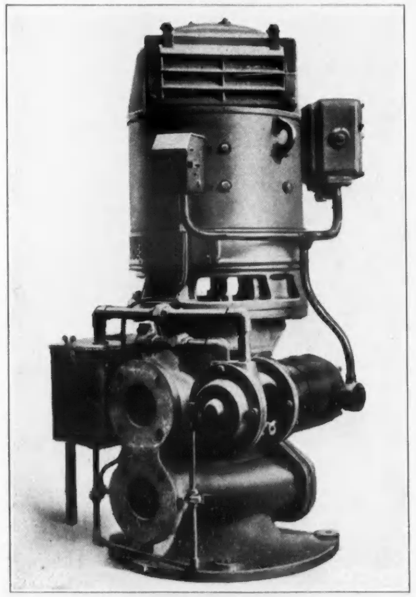

FIG. XII.—VERTICAL SELF-PRIMING PUMP—MIRRLEES

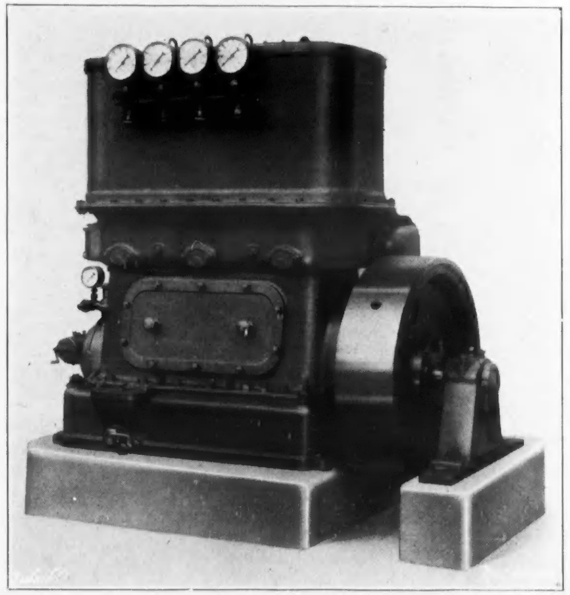

FIG. XIII.—3000 LB. PRESSURE AIR COMPRESSOR—BRITISH OXYGEN

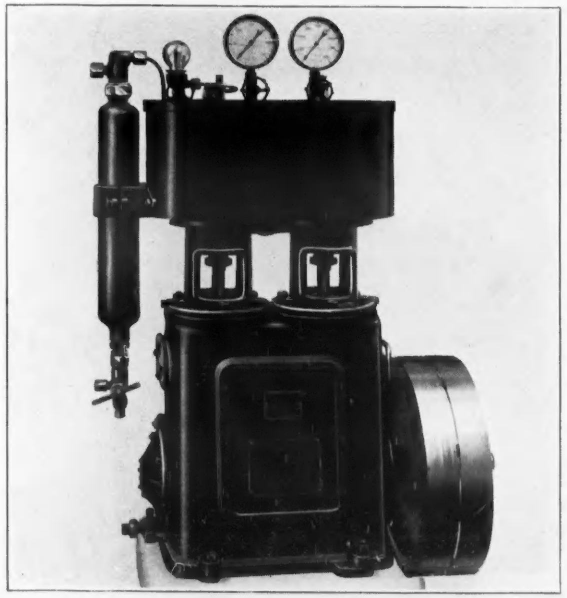

FIG. XIV.—150 ATM. GAS COMPRESSOR—BRITISH OXYGEN

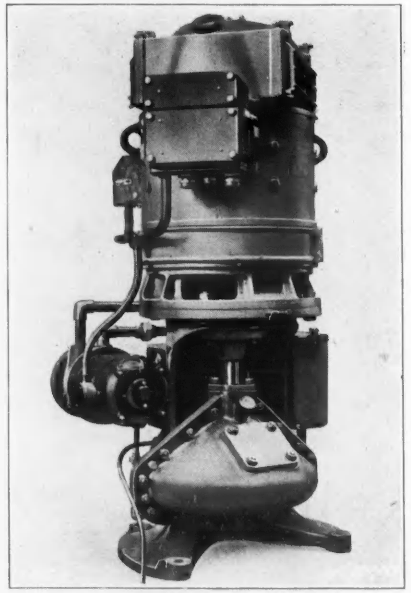

FIG. XV.—VERTICAL SELF-PRIMING PUMP—MIRRLEES

HIGH-SPEED MARINE OIL ENGINES AT OLYMPIA

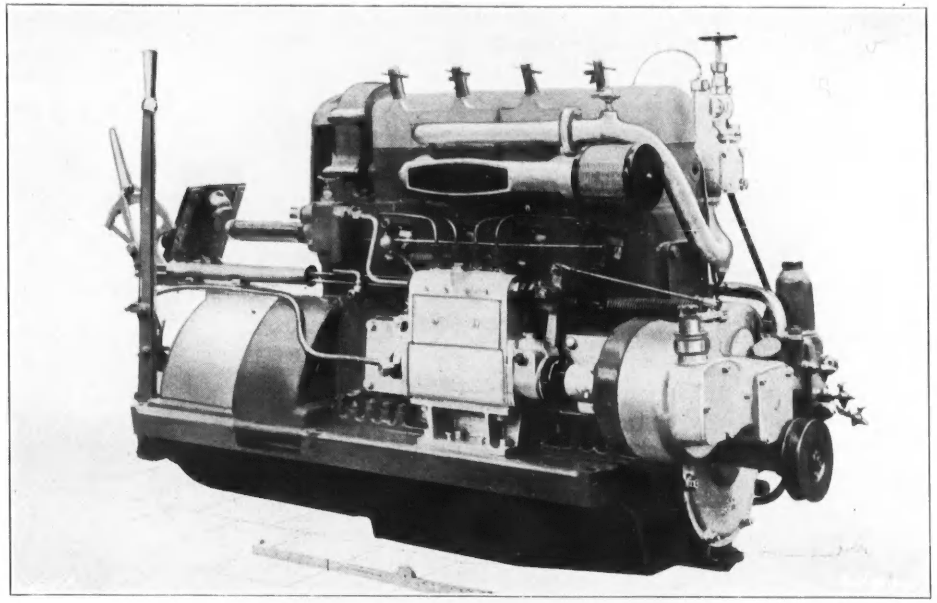

FIG. XVI.—25 B.H.P. FOUR-CYLINDER MARINE OIL ENGINE—MCLAREN

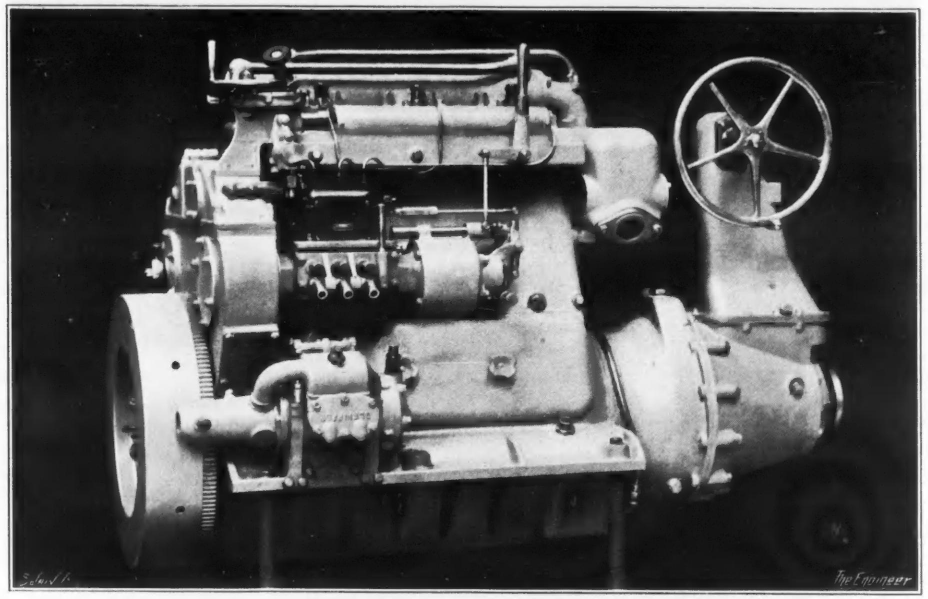

FIG. XVII.—36 B.H.P. THREE-CYLINDER MARINE OIL ENGINE—GLENIFFER

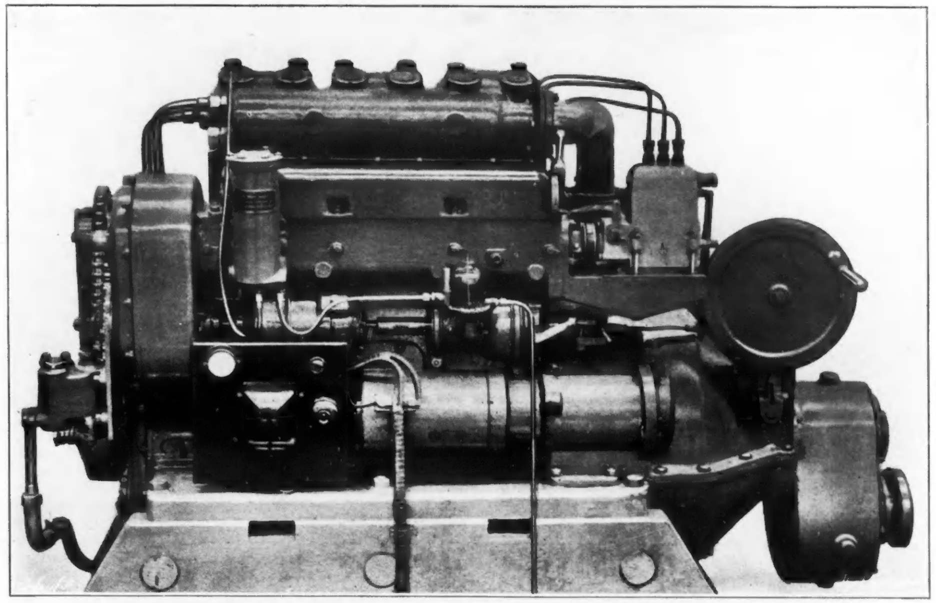

FIG. XVIII.—40 B.H.P. THREE-CYLINDER MARINE OIL ENGINE—ELECTRO-MECHANICAL

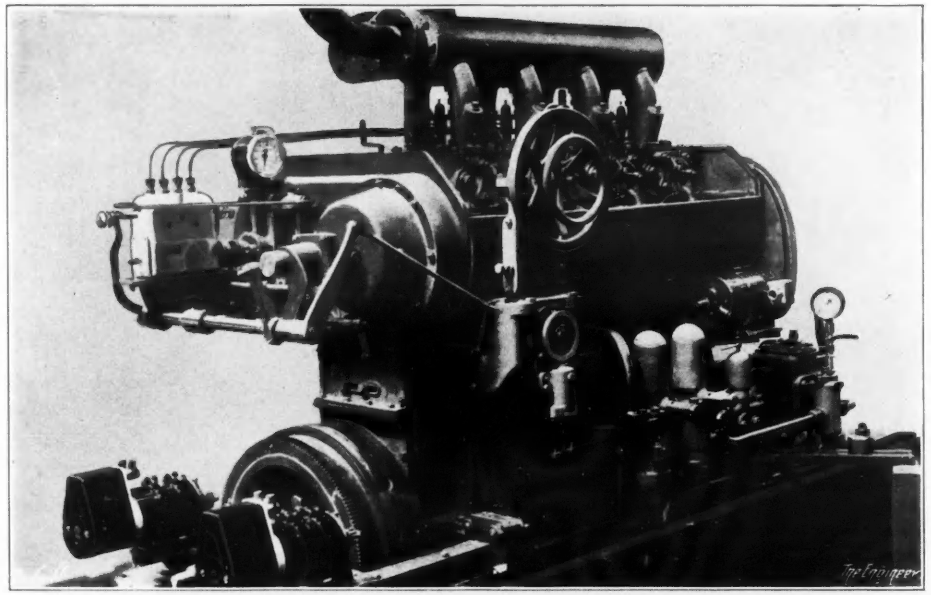

FIG. XIX.—100 B.H.P. FOUR-CYLINDER MARINE OIL ENGINE—DAVEY-PAXMAN

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SCIENCE AND PROGRESS.

To an evening discourse at the recent meeting of the British Association Sir Josiah Stamp gave the title " Must Science Ruin Economic Progress." The address, the substance of which is printed on page 294 of this issue, was well received, but it is of the kind that calls for greater application than even the most attentive and acute minded can give in the atmosphere of a lecture hall. For it is a closely reasoned philosophical inquiry into the relationship which does exist, and which might exist, between technological developments and the progress of mankind towards greater contentment. But besides being coldly logical and philosophical it is inconclusive. Sir Josiah expresses neither faith in man's ability to make the best of all that science and technology offer him, nor assurance that science is inimical to economical progress. He aligns himself neither with that party which abhors mechanisation nor with that which supports it. His position is one of calm detachment. He seems to say: " I give you the facts; it is for you to sort them out and draw your own deductions." No doubt he would add, under his breath, " Each one of you will, of course, select the facts that suit him and draw from them the conclusions he wishes to draw." That is a persistent human weakness, from which not even scientists always escape, and from which economists never do. The old saying, " Given a twelfth immersion microscope and a lively imagination, and you can see whatever you desire to see," is as true of economics as of other sciences. It may be that in a less sophisticated past economic issues were simpler than they are to-day, and that no more than macroscopical examination was required to see whither they led. But now they have to be examined with a microscope, and in the vast complexity of elements which are presented it is always possible to pick out those that suit one's own hypothesis.

For this reason Sir Josiah Stamp's address is salutary. It deals only in a broad way with the numerous factors involved in a problem which is disturbing the whole world, and concentrates attention on fundamental economic principles. Whether other economists will accept or reject those principles remains to be seen. Some of them appear to be startling enough to ensure immediate repudiation. When, for example, Sir Josiah asserts that " the *basic* economic reason for social unemployment relief is not the humanitarian argument of social obligation against distress, *or* the argument against revolution, but the plain argument that the gainers by innovation should bear the losses of innovation," we suspect that those who master the full meaning of the assertion will scarcely be content to accept every implication of it. If, to take but a single obvious example, a manufacturer introduces a new labour-saving appliance—an innovation—are we to understand that he must therefore make himself responsible for the labour the new appliance displaces? We ask the question in a spirit of inquiry, not of opposition, and in asking it we recall that under the Swope plan in the United States each industry was to make itself responsible for its own unemployed. But it would be unfair to pick out from the address a passage near the end before attempting to review what led up to it. Sir Josiah opened with a definition. " Economic progress," he said, " is the orderly assimilation of innovation into the general standard of life." Bearing in mind that " Economic " is used in its wide and not its commonly employed restricted sense, we do not see how this definition could be bettered. Man's power to assimilate for his own benefit, comfort, and contentment every advance of science and technology is the ideal at which to aim. If that assimilation does not take place quietly, if there are disturbances, as when the mob broke Arkwright's machines, or if what is called technological unemployment results, then and by so much there is a departure from economic efficiency. It is because these things happen, because innovations seem for the time being to have outrun man's capacity to benefit by them, that Sir Josiah was presented with the problem which he attempted to clarify, if not to solve. " It is," he said, " being commonly stated that scientific changes are coming so thick and fast, or are so radical in their nature and implications, that the other factors of social life, the intangibles of credit, the improvements in political and international organisations and ideas, are unequal to the task of absorbing and accommodating them, or else they present new problems which have no counterpart. If changes in social forms and human nature or behaviour cannot possibly be made rapidly enough for the task, then in that sense science may 'ruin' economic progress, and the world might be better served in the end if scientific innovation were retarded to the maximum rate of social and economic change." This quotation embodies the theme which Sir Josiah developed. One hundred per cent. economic progress can only be attained when a perfect balance between the rate at which innovations are introduced and the power to absorb them is reached. It is the difference in *tempo*, as he calls it, that causes the disturbances which technology is provoking in society at the present moment. Two kinds of balance have to be effected. The first is that " between two classes of scientific discovery, that which accelerates or makes easier the production of existing economic goods, and that which creates new kinds of economic satisfaction—the derivative and the direct." The second, " which is vital to economic progress and may be ruined by over-rapid innovation, is that between obsolescence and depreciation." Both these equations were analysed by the lecturer in detail. For the past hundred years the first kind of balance has been brought about automatically. Increased productivity has been met, on the one hand, by an increasing demand for the product produced, and, on the other, by the release of money for the purchase of other commodities—old or new. But " even if these two classes of innovation, direct and derivative, are in balance, the progress of absorbing them will give rise to economic 'growing pains,' and temporary dislocation of capital and employment, but the gains will rapidly outweigh the disadvantages. But when they are not in balance, the process is more painful, and the debit to be set against progress very much greater." This, we take it, is the kind of balance, or out-of-balance, which is the obvious cause of present unemployment. But in view of the fact that many desires and even necessities are unsatisfied in the world, it would not be fair to hold technological advances responsible for it. It is, we suggest, not innovation which is at fault, but rather that means to take advantage of innovation are out of gear. In other words purchasing power has not advanced *pari passu* with producing power. To the second kind of balance—that between obsolescence and depreciation—Sir Josiah devoted much attention. It is one of particular interest to manufacturers, but we can do no more than record two or three of the conclusions to which the lecturer was led. He found that " an over-rapid series of innovation may mean the scrapping or unprofitability of much excellent capital for very small marginal gains," that " the majority of modern innovation is of the type which does *not* pay the cost of obsolescence, and proceed by orderly and natural physical renewal or substitution," and that " no prices ought to be charged except on the basis of costs fully loaded with short-period obsolescence—this would prevent over-rapid substitution, economic only to a narrow range of people."

We should weary our readers if we attempted to condense into a few passages the remainder of an address which will certainly be studied with close attention by all serious economists. It must suffice to say that Sir Josiah discussed such matters as the place of leisure in economic progress; the power of " a socialistic organisation to obviate such of the maladjustments as depend upon gains and risks of absorption not being in the same hands"; and international relations, and foreign trade. Neither shall we attempt to make our own deductions from the arguments advanced in the address. Rather does it seem better to place Sir Josiah's own conclusion before our readers. It runs thus: " Economic life must pay a heavy price, in this generation, for the ultimate gains of science, unless all classes become economically and socially minded, and there are large infusions of social direction and internationalism, carefully introduced. This does not mean government by scientific technique, technocracy, or any other *transferred* technique, appropriate as these may be to the physical task of production; for human wills in the aggregate are behind distribution and consumption, and they can never be regulated by the principles which are so potent in mathematics, chemistry, physics, or even biology. Scientific workers may contribute much by sharing the problems of social science along its own lines, by giving a greater proportion of brilliant minds to this field, and by planning research."

The Growth of Scientific "Jargon."

At the British Association meeting at Leicester last week the alleged alarming growth of technical " jargon " attracted a considerable amount of informal comment and discussion. In certain quarters it was asserted that the obscure terminology adopted by numerous authors and speakers constituted a menace to the spread of scientific knowledge. The complaint is not merely that the general public is experiencing increased difficulty in following the papers and debates at the Association's meetings. The growth of " jargon," it is maintained, has now reached such a stage that authorities in any one branch of science are commonly at a complete loss to understand those in another, and even, on occasion, their brother specialists in the same branch. The trouble is said to be prevalent in varying degree in all scientific literature and discussion, and is not confined to the contributions made to the proceedings of the British Association. Typical of the views expressed are those of Professor B. W. Holman, of the Mining Department, Imperial College of Science, and Chairman of the Association of Scientific Workers. Professor Holman is an advocate for the use of " basic English " as devised by Mr. C. K. Ogden on lines first suggested by Jeremy Bentham. Ordinary communication in idiomatic English is, he says, possible by means of the 850 foundation words in the basic English vocabulary. To meet the requirements of science in general he would allow an addition of 100 words, while any particular science might be permitted to use an extra fifty of its own. The rapid progress of discovery and the rapid growth of terminology which has accompanied it have undoubtedly resulted in each department of science employing a language peculiar in many of its terms to itself. On broad grounds we must regret this development, and the passing of the days when a man of scientific intelligence could feel at home in half a dozen branches of study. But while our sympathies are entirely with Professor Holman and others who seek to establish the use of familiar English in scientific writings and discussions, our reason tells us that the development has been inevitable. The separation of the sciences by their adoption of different specialised terminologies must become ever greater as each cultivates its own field.

Science, consisting as it does of nothing but precision of observation followed by precision of thought, demands for the communication of its knowledge precision of expression. If it is to survive, let alone progress, it dare not employ loosely-defined terms. In at least nine cases out of ten, the definitions of common English words given in ordinary dictionaries are far too loose for scientific usage. The artistry of the poet and novel writer undoubtedly benefits from this looseness; it leaves room for the individual imagination of the reader to play among the shades of meaning. In the same spirit the artistry of the painter or sculptor is expressed in tone or line which by its lack of full definition and precision excites the beholder's personal interpretation. But in science there is no room for artistry and its appeal to the imagination. We have to present, not a painted canvas, but a photograph as sharp as it is within our powers to focus it. We have to speak, not in the faceted phrases of the poet or in the wilfully vague terms of the politician, but in words of trebly refined definition. In early days scientists expressed themselves naturally by means of words in common use. As their knowledge extended and their conceptions became refined it became essential to extend and refine their vocabulary. Expansion was achieved by the coining of new words or the adoption of foreign terms. Refinement of the existing vocabulary was effected by giving specially selected or restricted meanings to the common words of which it was composed. These two processes, the introduction of new terms and the refinement of the meaning of native words, are jointly responsible for the so-called scientific jargon of to-day. If the adopted or coined word constitutes jargon, then so, too, does the native word after it has been re-defined to suit the precise needs of science. Jargon, or, as the dictionary has it, "phraseology peculiar to a sect or profession," is created not by the words adopted, but by the act of attaching particular meanings to them. The familiar native word embedded in a scientific statement may not appear to be, but nevertheless commonly is, jargon or professional slang, just as certainly as the most patently and outrageously fabricated word. The sentence, "Stress is proportional to strain," is composed of nothing but simple familiar terms, but because of the closely defined meanings attached to the first and last words it is professional jargon of a high order, so high, in fact, as to make the statement utterly meaningless to the uninitiated. To-day it is the adopted or coined word which is singled out for attack as jargon, but it is not so many years ago in the history of science since the associated practice, the refinement of the meaning of common or native words, gave rise to precisely the same difficulties and protests. Difficulties were created when scientists first began to use the word "heat" in its modern sense as implying a quantity of energy. They were faced with protests that common usage—as in "summer heat" and "blood heat"—associated the word with another conception, the conception of temperature. In 1880 Sir William Thomson admitted the difficulty, and recognised the justice of the protest. To meet the situation he proposed that the term "caloric" should be retained—in spite of the abandonment of the materialistic theory of the nature of heat—to denote definitely "the measurable essence of heat"; that is to say, that quantity which could be measured by means of a calorimeter as distinct from the factor measured by a thermometer. Scientists to-day use "heat" in the sense of Kelvin's "caloric," but by giving it a precise and restricted interpretation they have added it as a word to their vocabulary of jargon in exactly the same manner as they have done by coining and defining "entropy." Frequently, as with "heat," the scientist makes jargon of a common word by simply selecting one of, possibly, half a dozen meanings attached to it, and rigorously excluding all the alternative definitions. This conscious process is eminently rational, and indeed is essential in view of the paramount necessity for precision and freedom from ambiguity. Occasionally he may appear to adopt a word with only half an eye on the dictionary. The engineer, for example, uses "fatigue" as applied to metals in a sense remote in some vital respects from its common significance. Doubtlessly, the term seemed, in its familiar meaning, an excellent one to describe the phenomenon to those who first observed it. We now know that it is really inappropriate, but we continue to use it. It is, in fact, to-day jargon just as much as would be "lassitropy," had such a terrible word been invented to designate the phenomenon. Many other common words adopted by scientists have become jargon, in a similar manner, with the passage of time and the accumulation of knowledge concerning the conceptions to which they give names. The formulation of Hooke's Law and its logical interpretation have led to a complete inversion in science of the dictionary definition of "elasticity." The use of the word "inertia" as a synonym for "mass" is as clear, and, on reference to the dictionary, as extraordinary a case of jargon as one could hope to find. Yet behind this usage lie centuries of observation and reflection and the culminating wisdom of Newton's First Law.

The growth of scientific knowledge must be accompanied by an equivalent growth of scientific terminology. The discovery of new phenomena and the establishment of new conceptions would produce an ever-widening circle of confusion if freedom to introduce new names were denied us. The most completely jargonised branch of science is mathematics, and it is certainly the most orderly. It is undoubtedly true that the use of jargon restricts or prevents the understanding of a scientific subject by anyone unversed in its meaning. The instruction of the uninitiated is, however, not the prime aim of science. Its object is the progress of natural knowledge, and the first essential towards such progress is the labelling or naming of the facts which are observed and the conceptions concerning them to which reflection gives rise. How far, it may be asked, would the theory of relativity have progressed if its exponents had been compelled to express their ideas by means of the same words as those employed in the exposition of the Newtonian philosophy. In what condition would botany and zoology be to-day without the vocabulary of deliberately invented classical jargon by which the species and varieties of plants and animals have been named systematically? The engineer has his own jargon and supplements it with that of most branches of science. Among electrical engineers its use is particularly evident, but the two older branches employ it almost as liberally, although perhaps less ostentatiously. Is it conceivable that engineering could have reached its present stage of development if engineers had from the outset been confined to a vocabulary of 850 basic words? Can we believe otherwise than that any attempt to reduce the magnitude and free growth of the language employed by engineers and scientists will have a definitely restrictive effect on their work and be responsible for confusion rather than progress? Science, directly or indirectly, is to-day the most powerful factor leading to the introduction of new words into common use. If its operation in that direction were artificially stopped our language would almost wholly cease to grow. Simultaneously, science itself would, it is certain, lose its vitality and become, like Cæsar's "Commentaries," a book that is finished. It would become supremely fit for exposition to a juvenile audience, but as a force moving the world it would be dead.

SIXTY YEARS AGO.

THERE is, or used to be, an Army phrase, "All Sir Garnet," employed to express the fact that everything is ready and in order. The phrase honours the memory of Sir Garnet (Viscount) Wolseley, and his ability to organise and carry through successfully difficult operations in many lands. Sixty years ago he was about to proceed on a campaign in Ashanti, which, although ultimately ineffective in securing the objects desired, brought him renown and high reward for the skilful way in which he conducted it. The King of Ashanti had refused to surrender to the British Government four Europeans whom he held prisoner. In January, 1873, he crossed the river Prah, the boundary between his territory and the British Gold Coast Protectorate. Somewhat leisurely, the home Government decided to punish him. Parliament voted £800,000 to cover the cost of the expedition, and Sir Garnet was instructed to take command of it. In our issue of September 26th, 1873, we described and illustrated the artillery equipment which was being provided for the campaign. We noted that the selection of the artillery and, indeed, the arrangements for the whole expedition had been left in the commander's hands to an extent which was unusual in military undertakings. The main equipment chosen by Sir Garnet consisted of a four-gun Howitzer battery with 1800 rounds of ammunition; two Gatling guns, and a quantity of small-arm ammunition, "exceeding the total number of rounds fired in the Russian War." Sir Garnet was given for the Howitzer battery the choice of either the 4½in. bronze smooth-bore Cohorn gun, or the more modern 7-pounder steel rifled gun. Both patterns were muzzle loaders. He selected the older smooth-bore pattern, on account of its simplicity, but we criticised his choice on the score that it was heavier and less accurate than the rifled gun. A special design of carriage was produced to meet the needs of the campaign in the almost untracked jungles of Ashanti. It was devised by Colonel Field and was designed and manufactured within a fortnight at the Royal Carriage Department. The carriage had a particularly narrow track, 2ft. 4in., to permit it to move along tracks not more than 3ft. wide. The Gatling guns were adapted for mounting on carriages of the same design instead of on the normal field carriage with a track of 5ft. 2in. Included in the equipment for the expedition were two "steam sappers," provided with wheels which could be adapted either to traverse soft ground, or, by inserting pegs in their tires, to ascend very steep slopes. Sir Garnet landed at Cape Coast Castle on October 2nd, 1873. He found 40,000 natives in arms against him. After severe fighting at Amoaful his army entered Coomassie on February 4th, 1874. It remained there only two days, for it was necessary to return to the coast before the rainy season set in. The capital was, therefore, set in flames and the army began its retirement. On the return march envoys from the King overtook it and concluded a treaty with Wolseley embodying all the British requirements. That treaty was, however, from the first, almost a dead letter. Under King Prempeh, the Ashanti nation continued to disturb the hinterland of the Gold Coast colony. The whole work had to be done over again. On January 17th, 1896, Sir Francis Scott, with a mixed British and native force, entered Coomassie and deposed Prempeh and his principal chiefs. Four years later the natives rose in rebellion and besieged Sir F. Hodgson and a garrison of 700 in Coomassie fort. Faced with starvation, 600 of the defenders managed to cut their way through to the coast. The remainder were eventually relieved by an expedition under Colonel Willcocks after a siege lasting nearly three months. On December 28th, 1900, the last of the rebels remaining in the field were captured, and in September of the following year, Ashanti was formally annexed to the British Dominions.

OIL FROM COAL.

ON Tuesday, September 19th, it was announced that orders had been placed in Sheffield by Imperial Chemical Industries, Ltd., for the plant required for the 100,000-ton per year hydrogenation installation which is to be built at Billingham-on-Tees. The orders, which amount to close upon a quarter of a million pounds, are mainly for forgings and other parts in highly specialised alloy steel, and will be executed by the English Steel Corporation, Ltd., and Thomas Firth and John Brown, Ltd. The two firms have agreed, in view of the special character of the work, to co-operate in solving through their joint technical staffs and laboratories any problems which may arise in forging and machining. It is anticipated that the work will occupy seven to eight months, during which the forges will be fully employed. Some of the largest forgings will weight over 100 tons and stainless steel will be used for pipes and valves.

METRIC UNITS OF VOLUME.

THE Chemical Divisional Council of the British Standards Institution has decided that in all British Standard Specifications prepared for use in the chemical industry in which reference to metric units of volume is made, the unit to be employed shall be the millilitre (abbreviation ml) in preference to cubic centimetres. For example, the millilitre has been adopted as the unit in terms of which British Standard volumetric glassware shall be calibrated, and as the unit to be employed in the description of analytical methods. The decision to adopt this unit was taken after careful consideration, involving a detailed study of the history of the metric units of volume and of current practice.

A similar recommendation was made by the Joint Committee for the Standardisation of Scientific Glassware in 1924, and has since been adopted in many important publications. Some journals, however, still retain the use of "c.c." The British Standards Institution considers that the general use of the millilitre in all journals is highly desirable. It is, therefore, hoped that editors of scientific journals and publication committees of scientific societies will give favourable consideration to the above recommendation, and, where this has not already been done, introduce the use of the millilitre into their publications at the earliest opportunity.

THE PORT OF LONDON.

ACCORDING to the twenty-fourth annual report of the Port of London Authority, recently issued, the total net register tonnage of vessels using the port during 1932 was 53,903,886 tons, against 56,074,556 tons for 1931, a reduction of 3·3 per cent. There was, however, a more serious decline in the volume of imports and exports, the total value being £409,371,000, which is £83,029,000, or 16·9 per cent., less than that reported for 1931. In the Authority's financial year, which ended on March 31st, a slight increase in both export and import tonnage was shown. There was also a small decrease in the net register tonnage of vessels liable to river duties, but an actual increase in ships engaged in coasting trade. The export trade handled by the Authority on the dock quays totalled 495,589 tons, which was a decrease of 21,887 tons compared with last year's figures. The more important works carried out by the Authority for the maintenance of its undertaking included extensive lock gate repairs at certain docks. At the Royal Albert Dock the quay cranes were overhauled and repaired, while at both the Royal Albert and King George V. docks, underground cables were substituted for overhead cables. During the year no less than 1,142,230 cubic yards of material were removed from the river in order to maintain and to deepen the navigation channels, while the quantity of mud removed from the various docks during the same period totalled 1,081,466 cubic yards.

BOOKS RECEIVED.

This Soft Age. By Ernest J. P. Benn. London: Ernest Benn, Ltd., 154, Fleet-street, E.C.4. Price 3s. 6d. net.

British Ships Illustrated. By A. C. Hardy, B.Sc. London: A. and C. Black, Ltd., 4, Soho-square, W.1. Price 3s. 6d. net.

The Unemployed Man. By E. Wight Bakke, Ph.D. London: James Nisbet and Co., Ltd., 22, Berners-street, W.I. Price 10s. 6d. net.

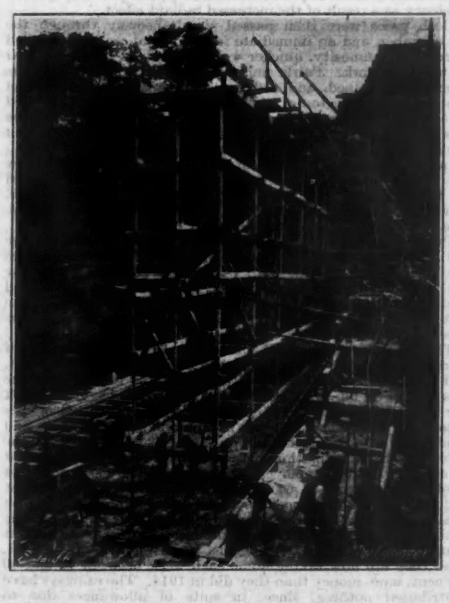
Rubber in Chemical Engineering. By H. P. Stevens, M.A., and M. B. Donald, M.Sc. London: The Rubber Growers' Association, 2, Idol-lane, E.C.3.

THE RYBURN DAM UNDER CONSTRUCTION AND COMPLETED

The Ryburn Reservoir.

◆

PRIOR to 1877, the city of Wakefield was supplied by a water company which pumped water from the river Calder below the town. What sort of standard of purity there was is doubtful, but it seems probable that it was low. At any rate, in that year the Corporation bought out the company and started the construction of the Ringstone impounding reservoir and other works on the Rishworth Moors, together with a storage reservoir at Ardsley. The new supply was inaugurated in 1887, and was both more plentiful and of better quality than the old. To keep pace with increasing demands—for Wakefield is in the midst of an industrial area, and was expanding rapidly—the Green Withens impounding reservoir was constructed at Rishworth in 1897, and five years later open sand filters at Kirkhamgate and a service reservoir at Lindale Hill were brought into use. Still further supplies were urgently necessary by 1917, and the Booth Dean dams and gauge basins were constructed at Rishworth between 1917 and 1922, and in the immediately following years the capacity of the Green Withens reservoir was increased by 25 per cent. By 1924, therefore, the water supplies for Wakefield and district had been brought to a level sufficient to meet all normal demands. Expectations of an expansion in demand, however, still remained to be met, and in 1924 powers were obtained to take water from the Ryburn valley, which lies to the north of the Rishworth Moors. The scheme included the construction of the Baitings and Ryburn reservoirs, a pipe line 20 miles in length, including a tunnel half a mile long, together with several bridges and additional filtration plant of the modern pressure type. On September 7th last, the opening ceremony of the new reservoir was performed by Councillor Charles Hopkinson.



STATE OF THE WORK IN SEPTEMBER, 1929

Above and on p. 284 we reproduce photographs showing a general view of the Ryburn dam, and its appearance at various dates during the time of its construction. This dam was designed by Mr. Clemesha Smith, the Corporation's waterworks engineer, and the work of construction was carried out under his supervision by direct labour. Curved in plan, it is of gravity section, constructed of concrete, has a full height from foundation to road level of 129ft., a length at the top of 600ft., and width at the base of 84ft. 6in. The volume of water impounded is about 220 million gallons. It is built across the Ryburn River just below the junction of that river with the Bogden Clough. Several novel methods were used in the construction of the dam. As usual, excavations for foundations were carried down until a suitable rock bottom was reached. But the cementation process was relied upon to reduce the depth of the cut-off trench. This trench was carried down a comparatively short distance. When the concrete was being laid within it, pipes were embedded therein to permit of subsequent boring at intervals of about 17ft. to depths between 100ft. and 200ft. At each end of the trench holes were bored for horizontal distances of 200ft. Cement grout was subsequently pumped down the holes at considerable pressure to force it into the joints of the rock. Usually, in excavation work of the class necessary for the construction of dams, 4in. diameter rotary drills are employed. The experiment of using 1⅞in. diameter percussive drills instead of the rotaries proved quite satisfactory, and brought about not only an increase of the rapidity at which the work was carried out, but a reduction by two-thirds in the drilling costs. Altogether, 150 holes were drilled, and 2278 tons of cement injected. The Francois Cementation Company, Ltd., of Doncaster, undertook this work.

As constructed, the upstream face of the dam is almost vertical, interrupted at its centre by the five-sided projection of the valve shaft. On the downstream side a stepped construction has been adopted. Nearly all the concrete was placed by gravity by means of chutes and tubes. Hopper wagons running on light gantries conveyed the concrete to those places which could not be reached by chutes. Altogether, a total volume of 60,000 cubic yards of concrete was required, crushed gritstone being obtained from quarries near each end of the dam above top water level. Shap granite concrete was used over the whole of the downstream face to provide a hard surface, and the upstream face was similarly treated for the upper 40ft. Six overflow bays arranged three on each side of the projecting valve shaft at the centre of the dam provide adequate capacity for dealing with flood waters. Beneath the valve shaft two outlet pipes, 24in. and 20in. in diameter, respectively, are fixed at about the level of the stream bed, while draw-off pipes at four different levels controlled by valves within the shaft supply the compensation water which the Corporation is under obligation to deliver into the stream. Use is made of this compensation water to drive a small Gilkes turbine supplying power for lighting and other services. A considerable proportion of the compensation water—about 400,000 gallons per day—is required by the Ryburndale paper mill, and an upward filtration plant on the Pennell-Wylie system has been provided to deal with it.

The cost of the dam, including such other incidental works as road diversions and filtration plant, has been approximately £235,000.

The Iron and Steel Institute.

No. I.

THERE are many who will share with the members of the Iron and Steel Institute their regret that the President, Mr. W. R. Lysaght, was prevented by illness from attending the autumn meeting, which was held between September 12th and 15th, at Sheffield. It is reassuring to know, however, that Mr. Lysaght has made a good recovery, and is now recuperating in Devonshire. A few months ago he celebrated his seventy-fifth birthday, and we are told that the illness from which he has just recovered was his first.

At the suggestion of Professor Sir Harold Carpenter, who presided at the meetings in Sheffield, a telegram was despatched to Mr. Lysaght expressing regret at his absence and good wishes for the future.

The first official function at Sheffield was a reception at the University on Tuesday evening, September 12th. The hosts and hostesses of the Institute's members and their ladies were Colonel H. K. Stephenson (Pro-Chancellor of the University), Mr. Newton Drew (Pro-Chancellor), and Mrs. Newton Drew, Dr. A. W. Pickard-Cambridge (Vice-Chancellor) and Mrs. Pickard-Cambridge, and Mr. and Mrs. Joseph Ward.

A very varied programme of social functions and visits to works was arranged, in addition to the meetings, by a very representative Reception Committee. It included a reception and dance at the Town Hall, by invitation of the Lord Mayor and Corporation, on Wednesday evening, September 13th; a banquet at the invitation of Sheffield industrialists on Thursday evening, September 14th; and on other occasions luncheons at the invitation of the industrialists. A special programme was arranged for the ladies during the afternoons, when the menfolk were visiting the many works which were open to inspection during the period of the meeting. The iron and steel industries of Sheffield and district have given a very clear indication of their appreciation of the work of the Institute by the readiness with which so many of the works have been thrown open to the members.

In addition, an exhibition of refractory materials manufactured in the Sheffield district was open for inspection at the University, and facilities were afforded for visiting the Sheffield station of the Institute's Corrosion Committee.

A Civic Welcome.

Assembling in the Mappin Hall at the University on Wednesday morning, the members and ladies were welcomed officially to the city by the Lord Mayor (Alderman Ernest Wilson). In his address of welcome, the Lord Mayor recalled that the Institute was founded in 1869, and was incorporated by Royal Charter in 1899. Its chief objects, he said, were the dissemination of knowledge of the science and technology of the manufacture of iron and steel, and the recording of progress in the art and metallurgy of iron and steel. The Institute was international in character, for of its 2000 members about 30 per cent. were resident overseas, and some seventeen foreign countries were represented in its membership. Thus, the members were continually enriched by contributions of a scientific or technical character from distinguished metallurgists of other countries as well as their own. The Institute carried on research work in association with the National Federation of Iron and Steel manufacturers and the Department of Scientific and Industrial Research. It had two important standing Committees, one studying problems of the corrosion of iron and steel, and the other the questions of soundness of steel ingots, under the chairmanship of Dr. W. H. Hatfield. Of the members of Council as constituted in 1905, when the Institute last met in Sheffield, under the Presidency of Sir Robert Hadfield, Sir Robert is to-day the only remaining active member of the Council. Sheffield was his birthplace, and his munificent gift of £5000 to the University recently was but one further evidence of his love for his native city. May this close association long continue!

Dr. A. W. Pickard-Cambridge, M.A. (Vice-Chancellor of the University), who added a welcome on behalf of the University, said that the University authorities always welcomed an opportunity of contact with those who were practically engaged in the application of the principles which were studied at the University, theoretically, perhaps, even more than practically. At the reception on the previous evening some of the visitors were able to gain some knowledge of the resources of the University, and the authorities desired that any criticisms or suggestions the visitors might care to make should be forthcoming, for nothing could help more than the criticisms of those who were practically acquainted with the subjects studied there and with the needs of the iron and steel industry. Professor Andrew, the indefatigable, insatiable, and irrepressible Professor of Metallurgy, would be the first to welcome any suggestion for the improvement of his Department. The authorities were anxious to do all they could to strengthen the bonds between the studies at the University and the profession, and had received the very greatest encouragement during the last two days from the noble gift made by Sir Robert Hadfield, who, throughout his life, had represented both the theoretical and practical sides in the best possible way. A man in Sir Robert's position would not have given such help on that and earlier occasions if the University was not trying to do the things it should do, and his gift would enable further experiments to be made in the development of metallurgy.

It was not very easy to define the relation between the University and the industry, but, roughly speaking, the University endeavoured to be, in the first place, a training ground to provide persons, already acquainted with the fundamental sciences, with a knowledge of which was absolutely necessary for the practical development of industrial methods, and it tried to supply the industries of Sheffield and elsewhere with a continuous stream of persons highly trained for the technical posts and for research work. It recognised that the theoretical side was fundamentally important and that there was nothing so unpractical as the neglect of theory. So far as its means would afford, it carried on research into metallurgical problems, and if there was any difference between the research carried on at the University and that carried on in the research departments of the works, it was, one supposed, that the practical needs were less immediately pressing at the University, so that the researchers could work more leisurely on fundamental problems and go over the field more often. Important discoveries often resulted from such work.

Another way in which the University tried to help industry was by carrying on an almost continuous consulting practice. Those who were not intimate with the University work could hardly realise how much of the time of the Professors and teachers there was devoted to answering problems put to them from outside.

The authorities hoped that the ties between the industry and the University would be strengthened by that meeting, and that they might regard all the members of that great conference as their best friends.

Professor Sir Harold Carpenter, in expressing thanks to the Lord Mayor and the Vice-Chancellor for the welcome they had offered, recalled that, as a young worker, he had attended the Sheffield meeting of the Institute in 1905, and that that meeting gave him his first introduction to the great men of the city. He recalled the venerable Mr. John Devonshire Ellis, and the world-famous Dr. Sorby at that meeting, and expressed his indebtedness for the inspiration he had derived from them. He also paid a tribute to Sir Robert Hadfield, and thanked him for his gift to the University, which, it was understood, was to be devoted exclusively to metallurgical work.

Great advances in engineering during the last twenty-five years, he continued, had depended ultimately on the development of materials and the extension of the range of properties they displayed. Development since 1905 had been accompanied by a steady demand for steels of better quality and greater diversity of properties. In particular, the automobile industry had been responsible for the extension of the use of alloy steels and for great advances in such fabrication processes as drop forging, tube-making and sheet pressing. Only in 1904 was the first paper on high-speed cutting steel published in the *Journal* of the Institute, the author of the paper being Mr. Gledhill. Although that was not an English discovery—or, at least, only partly—Sir Harold emphasised the fact that Sheffield, by the mere extent and quality of its knowledge, was able to take advantage of the discovery and to constitute itself one of the chief centres of the production and manufacture of that steel.

Discussing other developments in which the members of the Institute had played predominant parts, he mentioned first the work of the Committee on the Heterogeneity of Steel, under the chairmanship of Dr. Hatfield. The Committee was set up some years ago to try to improve the quality of ordinary mild steel. At the present meeting there would be presented the fifth report of that Committee, one of the most interesting ever presented to the Institute. Although the new scientific information contained in the reports was of the first importance, an even greater consideration was that, for the first time, the spectacle was presented in that Committee of a large number of members of one industry working with one aim in view. That had brought the work of the Institute into a new field and had shown the advantage of co-ordinated work of that kind.

Secondly, he mentioned stainless steel. So far as the chromium stainless steels were concerned, they were always associated with the name of Mr. Harry Brearley. It was doubtful whether the discovery of a really effective rust-resisting steel was ever contemplated by metallurgists before it was actually found. In 1910 Cushman and Gardner asserted that "the tendency to rust is a character inherent in the element known as iron, and will, in all probability, never be entirely overcome." That statement was strictly true, because the properties of an element could not be altered; but its implications bearing on the alloys of which iron was the base had been completely contradicted by subsequent events.

Then there were the creep- and heat-resisting steels. The first paper dealing with those metals was by Mr. G. H. S. Dickenson, of Sheffield, presented at the autumn meeting of the Institute in 1922. As the result of their development, the employment of metals at elevated temperatures had entered a new phase, and heat-resisting steels were giving satisfactory service at temperatures unheard of ten years ago.

RETIRING OFFICERS AND COUNCIL.

It was announced that the following would retire from the Council by rotation at the next annual meeting of the Institute :—

Vice-Presidents: Mr. A. Hutchinson, Mr. John Craig, C.B.E., Mr. E. H. Saniter.

Members of Council: Mr. E. J. George, Mr. J. S. Hollings, Mr. W. J. Brooke, Mr. F. Clements, Mr. H. C. Bond.

The first paper presented was on "Co-ordinated Heat Conservation at the Normanby Park Steel Works, Scunthorpe," by Mr. W. J. Brooke.

HEAT CONSERVATION IN STEEL WORKS.

In this paper the author discusses the problems which had to be solved in the search for economy at the Normanby Park Steel Works, Scunthorpe, the plant employed, and the results attained.

The problem to be solved was the practicability of utilising the necessary fuel coming into the works in the most efficient manner possible, all with a view to lowering the costs of the finished steel without primarily depending upon increasing the quantity of steel made—in other words, to obtain the utmost possible economy in production without having recourse to the purely dilution factor of big output.

The Normanby Park plant was designed in its original state by the late John Darby, of Brymbo, in 1909, and was completed and put into operation in July, 1912, and, therefore, celebrates its coming-of-age this year.

In the early history of the firm, it was the intention to utilise both coke-oven and blast-furnace gas as far as practicable, but for various reasons that was only partially carried out.

Prior to the new scheme coming into operation it was the practice to utilise gas as far as possible. Thus, the mixer and soaking and recuperator pits were heated with blast-furnace gas mixed with coke-oven gas when there was any to spare. Steam and most of the blast for the furnace was raised by means of blast-furnace gas. Even before the present improvements were installed, considerable economies had already been effected in the utilisation of gaseous fuel, and there being a ready market at that time for basic pig iron, a considerable excess of blast-furnace gas was made and constantly going to waste. Owing to the superfluity of this gas it is to be feared that sufficient effort had not been made to utilise it as efficiently as possible.

The author was definitely of the opinion that with the installation of modern ovens, coking at high temperatures, a much improved quality of coke should be obtained which, it was anticipated, would have the effect of reducing the quantity required per ton of pig iron.

He was also convinced that as the scheme in mind depended entirely for its success upon a constant supply of gas from the furnaces, steps must be taken to ensure them working with the utmost degree of regularity. The better quality of coke anticipated would form one factor, and the other must be the preparation of the ores to as nearly a constant uniformity as possible. To this end it was considered advisable to install a screening and crushing plant, to deal with the ores prior to charging into the furnaces.

Having arranged the regular supply of blast-furnace gas, it was decided to use a proportion to heat up the coke ovens, leaving all the rich gas for use where most needed. The first thing to be done was to investigate the approximate consumption of blast-furnace gas at the various points where it was used, and whilst this was not possible at that time with any degree of accuracy, sufficiently near results were obtained for calculations to be made. The results proved that in many cases gas was being used in a very extravagant manner and with disconcertingly inefficient results, but by the installation of recording meters at the soaking pits and other places valuable information was gradually accumulated. Improved burners were devised for use on the boilers, which effected remarkable savings.

Owing to the inefficiency of the boilers and the intermittent supply of blast-furnace gas, stoppages at the mill on account of steam shortage were frequent, and whilst for a long time it had been known that the boiler brickwork required repair, it had not been possible to do this owing to the inability to spare one or two boilers "off" for the requisite period of time. On account of the improvements effected by the new burners it was possible to do this, and the boilers were gradually taken off in pairs and completely rebuilt. The outside of the new brickwork was encased with steel plates, allowing for 2¼in. of insulating material between the walls and the plate binding. Immediately these boilers were put into operation after rebuilding, it was found that the air orifice to the burner was not large enough to burn sufficient gas. In the first case the air orifice was 6in. diameter × 7, equal to 197·89 square inches. This was increased to 8⅛in. × 7, equal to 360·792 square inches. This effected an immediate improvement, and is the design in use to the present day. The difference shown was due to the new brickwork having prevented the infiltration of air, which previously had helped to support combustion. Under the new conditions the whole of the necessary air was now supplied by the burner, with most beneficial results.

Blast-furnace Stoves.—One stove was attached to a turbo-blower fitted with a specially calibrated Venturi orifice for measuring the volume of air blown. It was found that almost perfect combustion was obtained with a minimum of excess air, whilst the waste gas temperatures indicate that the loss of heat to the stack was almost a minimum. An examination of the waste gases from the remainder of the battery of stoves showed that similar efficiencies were being obtained throughout, and it was considered that under these conditions there was no case for the installation of a more elaborate type of gas burner or checkerwork.

Regenerative Soaking Pits.—It was decided to find out how much gas per hour was being used in these pits. Recording meters were therefore installed, and by 1928—owing to the use of these meters—the quantity of mixed gas had fallen from 800,000 cubic feet to 563,000 cubic feet per hour. This reduction could be attributed almost entirely to the meter installation, as the accurate recording of the gas enabled one to devote closer attention to the settings of the air valve and chimney damper. The constantly fluctuating pressure of the blast-furnace gas made it very difficult to obtain higher efficiencies.

Recuperative Pits.—Here the most important item was to investigate the proposition of using mixed blast-furnace and coke-oven gases on the steel furnaces. Here a difficulty was met with. The ovens at the best rarely yielded more than 15 per cent. of surplus gas, and usually that was all required for use at the soaking pits. Recourse was had, however, to the week-end working of the steel furnaces, and two furnaces were fitted with the necessary gear to enable preliminary experiments to be carried out. That was only possible on the first charge on Sunday each week, and there was only enough gas for one furnace.

The blast-furnace gas was first of all put through the checkers, and the coke-oven gas was admitted into the uptake of the gas port. That was immediately found to be wrong; little mixing of the gases took place, and whilst the furnace roof could be melted with ease, the same could not be said of the charge. The next step was the admission of the gas into the regenerator chamber above the level of the checkers. That was an improvement, and several heats were made in this manner. Careful measurements of the hourly quantities of the two gases were made. Perfect admixture of the gases, however, was still not obtained, and difficulty was experienced in that the degree of luminosity usually found with producer gas was not obtained, and this created considerable difficulties in the use of the gas by the furnacemen.

It had previously been asserted that the rich gas must not be passed through the hot checkers on account of the liability of the hydrocarbons to become dissociated, but from a little consideration the conclusion was drawn that that was what was needed in order to produce luminosity, and probably greater efficiency as a result of the increased radiant effect.

Both gases were then passed simultaneously through the gas chamber, and an immediate improvement was experienced as regards luminosity, quicker working, and less wear and tear on the brickwork. Fairly uniform times of working the heats were now obtained, and a figure representing the number of heat units used per ton of steel made, which could be employed as a basis for future calculations, was obtained. That figure was undoubtedly on the high side, as the calorific power of the coke-oven gas was not high, being only some 460 B.Th.U., as against the 520 B.Th.U. or more expected with the new ovens. It included, however, the quantity of gas required for the manufacture of a number of grades of high-class steel, which invariably took longer in the furnace to manufacture. The figure thus taken was 6,600,000 B.Th.U. per ton of steel.

Previously, the blast-furnaces, using a very lean mixture of Lincolnshire stone, consumed about 32 cwt. to 33 cwt. of coke per ton of pig iron, but with the expectation that the sizing of the ore and improved coke would reduce this, it was calculated that 31 cwt. of coke per ton would be used. This gave the quantity of pig iron that would have to be made to create the necessary amount of gas.

The ultimate aim of all these changes—the reduction of working costs—has been achieved to a quite satisfactory point, and as an instance of this it is now possible to produce coke at a cost of 3s. 6d. to 4s. per ton less than the price of the slack per ton delivered at the ovens, after giving the usual credits obtained by the sale of sulphate of ammonia, crude benzole, and crude tar, at current market prices. Gas is credited to the extent of the participation of the oven gas in the displacement of coal previously employed, and varies with the amount of steel produced from 3s. 6d. to 4s. per ton of coke. From this it will be readily understood that basic pig iron of the very best quality is now being made at a cost that is less than anything achieved in Lincolnshire since the early years of the present century. The workmen at the blast-furnaces have not suffered, since they are now taking home each week between 70 and 80 per cent. more money than they did in 1914. The railways have contributed nothing, since, in spite of allowances due to de-rating, some 10 per cent. more is still being paid for the assemblage of the blast-furnace raw materials than was paid before the war.

DISCUSSION.

Mr. F. Clements (Member of Council), after congratulating Mr. Brooke and his collaborators on the courage with which they had faced the problem of reducing production costs, said an appendix to the paper indicated a production of 3866 tons of pig iron and an equivalent production of 4617 tons of steel. He felt quite sure, however, that that weight of pig iron was not absorbed in making the weight of steel indicated. Hence, in order to make the operations balance, Mr. Brooke had to assume a market for that excess pig iron; in so far as that assumption was made, the works were not in balance. Plants which had not the benefit of blast-furnaces, of course, had to depend on outside supplies.

The cost of the final product, of course, could be affected by the prices charged for inter-departmental services, and that led him to discuss the price of gaseous by-products utilised in the production of iron and steel. Coke oven gas was saleable at 9d. per thousand cubic feet, equivalent to 1·8d. per therm

(100,000 B.Th.U.), assuming that the calorific value of the gas was 500 B.Th.U. per cubic foot. The value of hot gas produced by modern gas machines could be valued at 1·67d. per thousand cubic feet, or 0·78d. per therm, that figure including depreciation, labour, and all other costs. A very conservative estimate of the value of blast-furnace gas was 0·5d. per thousand cubic feet or per therm, assuming that the gas had a calorific value of 100 B.Th.U. per cubic foot. If, therefore, one compared these various classes of gaseous fuel against the hot machine gas as a basis, the value of coke oven gas on a heat basis was 3·9d. per thousand cubic feet. Therefore, if Mr. Brooke charged the gas to his open-hearth plant at a figure greater than 3·9d. per thousand, the open-hearth plant was suffering; if, on the other hand, he was not charging the gas in at a market value of 9d., then the coke oven plant was suffering. Bearing in mind that it was worth his (Mr. Clement's) while as an ordinary consumer in Sheffield to use gas for heating and cooking, at 2s. 8d. per thousand cubic feet, and that the gas supplied was coke oven gas, it became evident that the use of coke oven gas in an open-hearth furnace at the low price he had indicated earlier resulted in wastage of a national asset, for there were other markets for it and the community would benefit greatly if it were sold in those markets. Again, he discussed the utilisation of blast-furnace gas in gas engines for the generation of electric power (a furnace with an output of 1000 tons of pig iron a week would supply 6000 kW), and said that if a profit of 0·05d. per unit of electricity could be made the value of the blast-furnace gas was at once enhanced to 3·5d. per thousand cubic feet. If that were so, he was almost tempted to say that it should not be used for low-grade services. He could not be persuaded that Mr. Brooke's mixture of coke oven gas and blast-furnace gas was as good as the normal product of a gas machine for use in open-hearth furnaces.

These considerations led Mr. Clements to suggest that, in order to ensure the proper utilisation of coke oven and blast-furnace gas throughout our industries, there should be cokers of large output centred in appropriate centres using blends of coal which would produce uniform coke possessing the best properties, that the coke ovens should be fired with gas made from breeze out of the coke, and that the coke oven gas should be fed into a national grid for use by the community. He did not think there was any real case for the combination of cokers with blast-furnaces, but he visualised a national blast-furnace industry, blast-furnace activities being concentrated in appropriate places at which large outputs would be attained, and the gas used for power generation. If there were an output of 10,000 tons of pig iron per week the gas produced would serve a power station and would provide 60,000 kW continuously, and that could be fed into the national electricity grid. He saw no connection between blast-furnaces and open-hearth furnaces, and saw no reason why the steel plants of the country should not be located with reference to their markets. When allowance was made for cost of transport of materials one could still show a handsome gain. He claimed with confidence that such an orientation of operations would give a commercial efficiency unequalled in any other country in the world. Such a scheme was Utopian, but not impossible.

Mr. F. W. Harbord (Past President), discussing the operation of the coke oven gas in the open-hearth furnace, said he believed Mr. Brooke was right in saying that one must use a higher temperature, and suggested that his difficulties of foaming were due to high hydrogen content; he seemed to be right in assuming that that was due to moisture.

Discussing Mr. Clement's suggestion that there should be a central grid for blast-furnace and coke oven gas, he pointed out that if such gas were fed to a grid it was necessary generally to make a contract. He believed there had been some difficulties in that connection in Germany. If one had contracted to supply to a grid a definite quantity of gas per week, and if trade were bad, one might have to run the blast-furnaces as producers merely to supply gas to the grid. That was a very serious obligation for any industry to undertake, and he was inclined to think that the future of the industry was far more likely to be preserved by making each unit independent and of a reasonable size, which could be controlled by one man.

Mr. James Henderson (Vice-President) joined issue with Mr. Clements with regard to the establishment of a gas grid, for it was quite apparent, from the evidence given to the Area Gas Committee in London—of which he was a member—some time ago, that the cost of distributing coke oven gas was so considerable as to limit very definitely the area which could be supplied profitably. He believed also that that had been the experience in Germany.

Commenting upon a statement in the paper that the regenerative soaking pits were fired with blast-furnace and coke oven gas, he suggested that such use of coke oven gas was possibly not the most economic. It was the experience at Frodingham and Appleby that the type of furnace referred to could be served very well by blast-furnace gas. A coke consumption of less than 26 cwt. per ton of basic pig iron produced, which was the consumption of two furnaces mentioned in the paper over a period of months, was excellent. Figures approaching that had been attained at times at Frodingham and Appleby. The low figure mentioned in the paper was probably due to the excellent coke used and to the excellent crushing and screening of the ores. The coal consumption of 1·5 tons per ton of steel, which was the end figure given in an appendix, was excellent. He did not know of anything equal to it in this country, and doubted whether there was anything much better on the Continent. He pointed out, however, that the quantity of pig iron made was 3885 tons and the ingots made represented 5370 tons. There appeared to be a usage, if all the pig iron were used, of about 70 cwt. So that actually the consumption of 1·5 tons of coal appeared to be based on the tonnage of ingots, and that quantity represented a certain amount of raw material which had not gone through the blast-furnace.

Mr. Brooke, in a brief reply to the discussion, said he disagreed absolutely with Mr. Clements concerning the supply of gas to the grid. With regard to coal consumption, the figure of 1·5 tons of coal per ton of steel had been beaten during some weeks and that figure had included all the coal used on locomotives, cranes, and so forth, so that the figures given in the paper represented practically common practice at the works. Mr. Brooke indicated that he would reply in greater detail in a written communication.

A paper entitled "Notes on the Utilisation of Blast-furnace Gas," by W. B. Baxter, was then taken. The following summary is taken from the text:—

BLAST-FURNACE GAS.

Blast-furnace gas is no longer looked upon as a waste product of the blast-furnace, but as an essential factor in the working economy of a combined plant. It is important, therefore, that this valuable product be conserved and used as efficiently as possible.

How this is being accomplished at Appleby is indicated by the test results which form the seven Appendices to these notes. The tests are chosen as typical examples of the utilisation of the blast-furnace gas for various purposes. They were not made under ideal or staged conditions to demonstrate maximum efficiency, but to show what was happening under present-day practice in order to detect where improvements in working might be achieved.

The data obtained from the tests collected in these Appendices justify the policy of the use of blast-furnace gas and the gradual elimination of coal. The effect of this policy is well shown by the large reduction in the use of solid fuel at the Frodingham works. The following figures show the consumption of solid fuel expressed in cwt. per ton of ingots produced. They do not include blast-furnace coke, but do include the solid fuel used for all other purposes in the iron and steel works such as coal for steel furnaces, boilers, locomotives, travelling cranes, and all the smaller consumers:—

1913	..	17·2	cwt.	of coal	per ton	of ingots
1924	..	10·65	,,	,,	,,	,,
1928	..	7·95	,,	,,	,,	,,
1933 (half year to June 30th)	..	7·13	,,	,,	,,	,,

The Appleby blast-furnace and steel plant has benefited from the experience gained at Frodingham, and the total consumption of coal for all purposes for the first half of the year 1933 amounted to 4·61 cwt. per ton of ingots, which figure includes the coal used in the melting shop for the production of ingots, namely, 3·35 cwt.

DISCUSSION.

Mr. F. H. B. Gough, commenting upon a statement that in the first half of 1933 the amount of coal used per ton of ingots was 7·13 cwt., asked what was the total amount of coal used in the production and the rolling of the ingots. One assumed that it would be in the region of 36 cwt. or 37 cwt.

Mr. A. F. Webber (National Federation of Iron and Steel Manufacturers) referred to some curious features in the boiler figures. It might seem hyper-critical, he said, to suggest that there was anything wrong with a boiler showing an efficiency of 83 per cent. on test, but the temperature at which the flue gases left the boiler, 347 deg. Cent., seemed abnormally high, being more than 300 deg. Fah. above the temperature of the water in the boiler, so that it seemed that there was something wrong with the heat transmission in the boiler. Again, the economiser installed provided only some 40 deg. Fah. rise in the feed-water temperature, and he questioned whether the expense of an economiser was justified for so small a rise. Perhaps that could be effected with exhaust steam, in which case the flue gases, at present passing through the economiser, could be used to preheat the gas. If that were done, the gas temperature would be about 140 deg. Cent., the combustion conditions in the furnace would be markedly improved, heat transmission would be very much higher, and it was almost certain that the overall efficiency would be still further improved by the reduction of the heat loss in the waste gases. With a boiler of that description, test efficiencies of 88 to 90 per cent. ought to be practicable, and blast-furnace gas was probably about the best boiler fuel there was.

Mr. Baxter, replying to the discussion, said that the excess air was something like 220 per cent., and that figure was arrived at by analysis. The figure was due to air leakages and as there was a draught in the chimney it did not appear to alter the balance very much. Replying to Mr. Webber, he said the efficiency of 83 per cent. was so far ahead of that usually attained at iron and steel works that perhaps those responsible at Frodingham had been too easily satisfied. He had not the slightest doubt that several refinements could be made which would increase the efficiency of the boiler. One boiler was fitted with an economiser and another with an air preheater, and the efficiency of both of them was round about 83 per cent.

The following papers were taken as read, but there was no time for oral discussion:—"Some Factors Leading to Greater Production from a Steel Furnace," by Arthur Robinson; "The Effect of Tin as an Impurity in Mild Steels," by Professor J. H. Andrew and J. B. Peile.

The meeting then adjourned until Thursday.

VISITS AND EXCURSIONS.

The city of Sheffield, in which the members of the Iron and Steel Institute recently held their meeting, has two reputations. One, for smokiness, is undesirable. The other, dealing with its manufactures in cutlery, steel and iron, and in particular with alloy steels, is recognised over all the world. In consequence, and in spite of the smoke which, in this year of depression, was not as much in evidence as it should be, the city is a Mecca to which every metallurgist and engineer must sooner or later make a pilgrimage. The very approach to it, by rail at least, is a delight. Apart from such evidences of industry as the darkening sky, the host of chimneys, the great bulk of blast-furnaces, and the banks of boilers standing in the open air convey, the traveller may peer at times into the very heart of things, and catch glimpses of glowing metal on its way to the rolling mills or being moulded to form beneath the hammer.

That Sheffield can hardly be called a beautiful city is of less concern than that it is a highly industrial one. To pass through it by rail, even to spend an hour or two in its streets, conveys the impression that far from being a city it is no more than a collection of works gathered together by reason of some geographical or other advantage of the site. Modification of such first impressions is necessary on closer acquaintance. Sheffield is neither so smoky nor so ugly as it is sometimes painted, as those members of the Iron and Steel Institute—surely a small minority—who had not visited the city before discovered. Sometimes the seemingly haphazard collection of shops approaches the picturesque. The works of Samuel Osborne, as seen from the viaduct, might be taken as an example; and the city contains a number of fine buildings, including the new City Hall, in which the citizens take great pride.

If Sheffield itself is largely a collection of works erected without thought of beauty, and attractive in certain lights only by some freak of their haphazard arrangement, it has the compensation that, in the words of Lord Palmerston, it is "A black picture set in a golden frame." The countryside around it, and particularly over the county border into Derbyshire, can be reckoned as one of the best districts in England. A journey of less than half-an-hour by train brings the jaded worker to a country of wide hills and valleys, to stretches of high moorland and fresh winds untainted by smoke. Having previous knowledge of Sheffield, it was here that we elected to stay for the duration of the visit of the Iron and Steel Institute, although the programme arranged gave us little leisure to do more than enjoy the immediate prospect from the windows of the hotel.

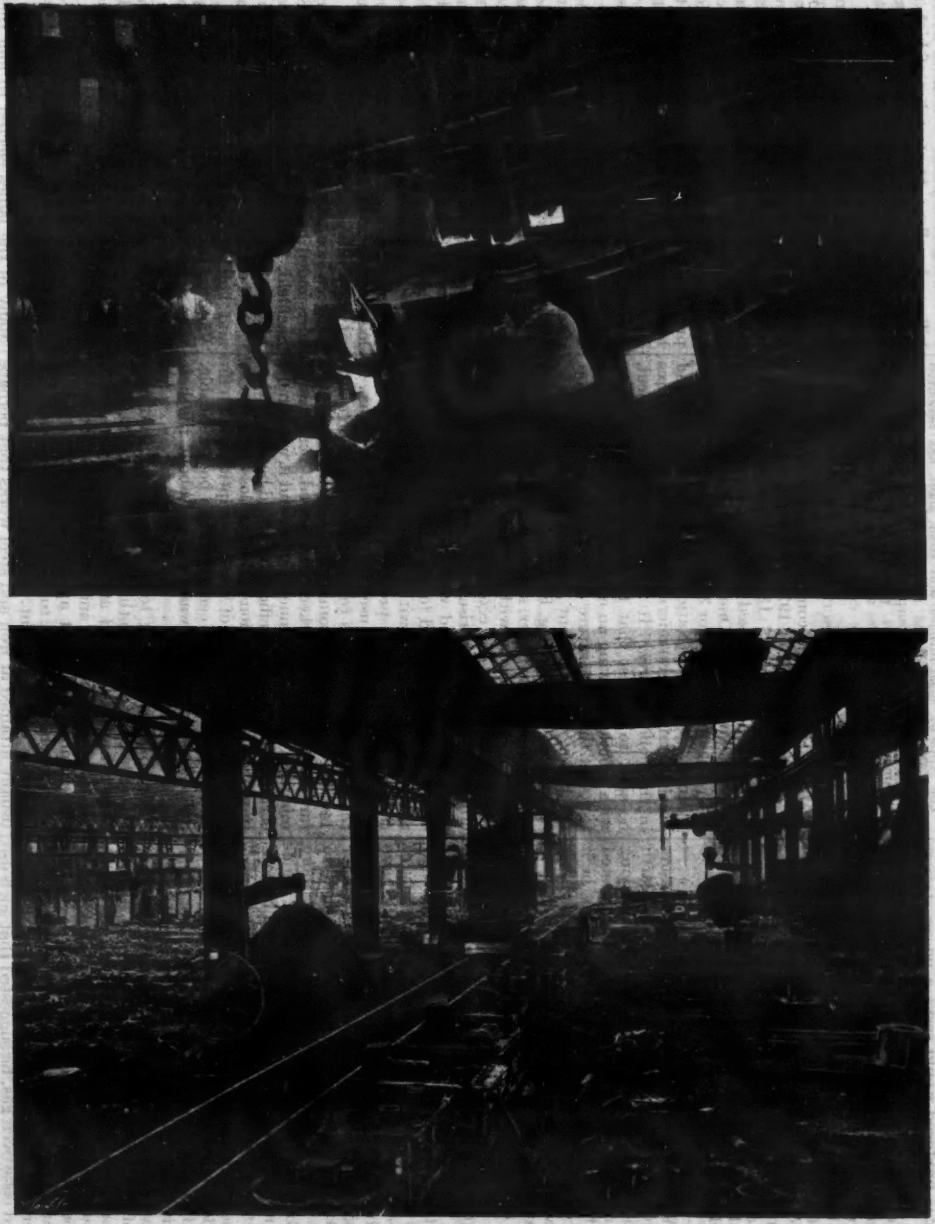
Officially proceedings opened with a reception by the University of Sheffield, Department of Applied Science, St. George's-square, at 8.30 p.m. on Tuesday, September 12th, but the honorary secretary's office in the same building had been open for some hours previously. From that time onwards the University building became the temporary headquarters of the Institute. Meetings of this kind are a curious and pleasing mixture of business and pleasure. There is something of the holiday spirit about the members, so that the business side, that of the reading and discussing of papers, is not taken too seriously. Following the welcome to the Institute by the Lord Mayor of Sheffield and the Vice-Chancellor of the University, only those with some particular interest in the subject under discussion, or with a highly developed sense of duty, attended the meetings in the Mappin Hall. Even so, the hall was always comfortably full. Many members, however, decided that since both papers and discussion would be printed and published in full, and could therefore be examined at leisure at some future date, the opportunity to see the city of Sheffield should not be missed. The official badge, a small medallion bearing the arms of Sheffield, surrounded by the words "Iron and Steel Institute, Sheffield, 1933," was therefore to be seen around all places of interest in the city during the morning.

At the invitation of Sheffield industrialists, members and ladies lunched, on Wednesday, at the Royal Victoria Hotel, at 1 p.m., and subsequently parties were made up and conveyed by charabanc to various works in the city, which included those of the English Steel Corporation, Ltd., Steel, Peech and Tozer, Ltd., Staveley Coal and Iron Company, Ltd., Corporation Electric Power Station, Walker and Hall, Ltd. (silversmiths and cutlers), Edgar Allen and Co., Ltd., Sheffield Coal Company, Birley, Brown Bayley's Steel Works, Ltd., Darwins Ltd., B. Huntsman and Co., Ltd., and Markham and Co., Ltd., Chesterfield. Many of the ladies elected to join these parties, but a tour through the beauty spots of Derbyshire proved a more popular counter attraction. In the evening there was a reception and dance in the Town Hall, at the invitation of the Lord Mayor and Corporation.

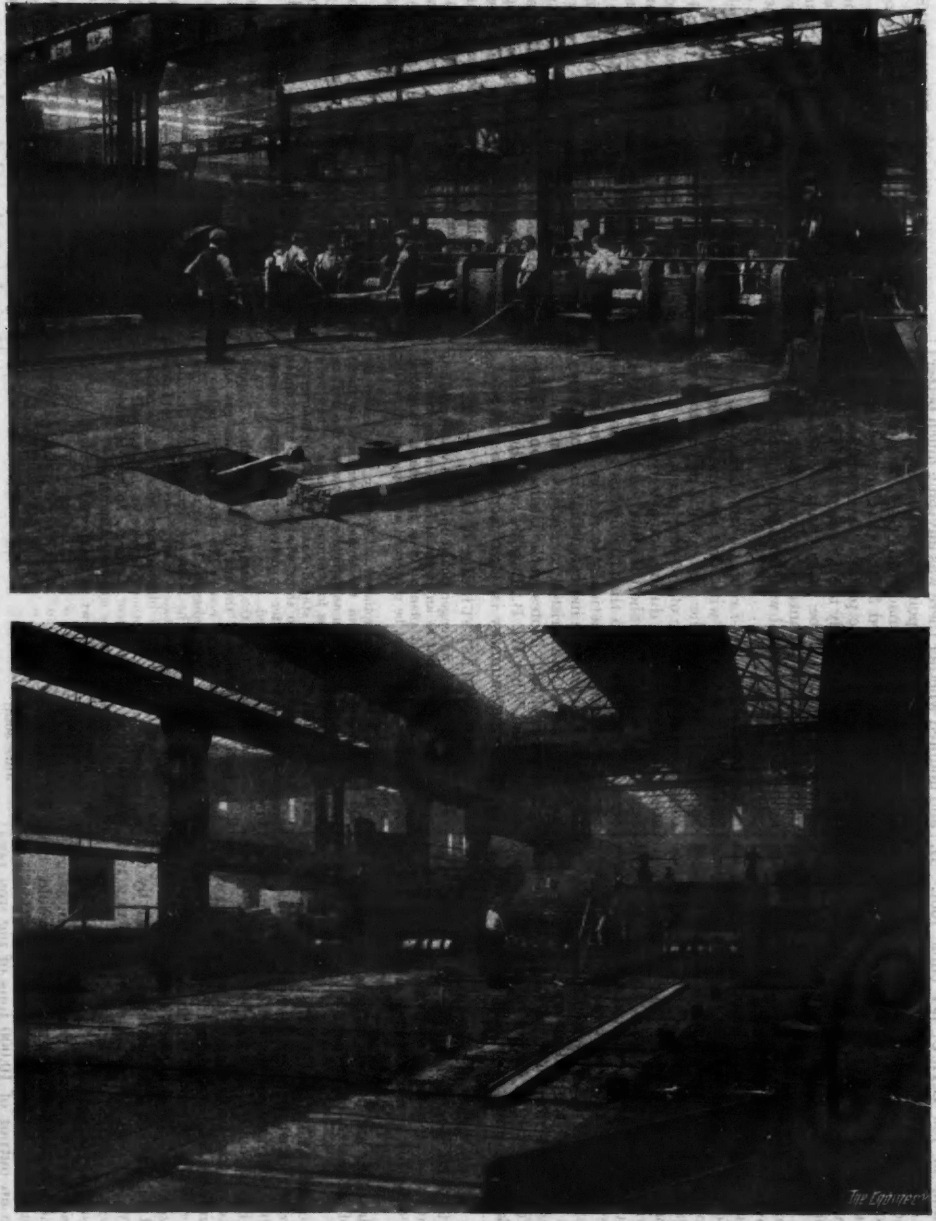
The programme for the following day was much the same as that which preceded it. The quota of papers to be read was brought to a conclusion in the Mappin

THE WORKS OF HADFIELDS LTD., SHEFFIELD, VISITED BY THE IRON AND STEEL INSTITUTE

(For description see opposite page.)



ABOVE :—TAPPING A LARGE ELECTRIC FURNACE
BELOW :—THE STEEL FOUNDRY



ABOVE :—ELECTRICALLY-DRIVEN 11 INCH ROLLING MILL
BELOW :—THE 28 INCH ROLLING MILL

Hall during the morning, and after luncheon motor coaches were again available to take members to the works of Thos. Firth and John Brown, Ltd., Hadfields, Ltd., Park Gate Iron and Steel Company, Ltd., Sheffield Gas Company, Thos. W. Ward, Ltd., S. Osborn and Co., Ltd., Viners, Ltd. (Silversmiths and Cutlers), Low Temperature Carbonisation, Ltd., or Jas. Neill and Co. (Sheffield), Ltd. Personally, we chose, with about eighty others, to visit Hadfields' East Hecla Works. Sir Robert Hadfield himself met and accompanied the party round the works. One of the first matters to attract attention was an exhibit of shells. The penetration of armour by a projectile presents little difficulty so long as the angle of approach is nearly normal to the plate. If, however, as is nearly always the case, the angle of approach is oblique, the rear part of the shell is likely to be broken away during the process of penetration, so that when explosion subsequently occurs a free path for the gases is provided through the non-existent back of the casing, and the body of the projectile is not shattered. To overcome the difficulty, there is provided at the back a ring which may fracture and fall away, but within the ring there is a solid casing enclosing the explosive. In an address of welcome to the members by Sir Robert Hadfield that lies before us as we write, and contains some highly interesting reading, some figures of tests upon modern armour-piercing projectiles are given. A shell of 15in. or 16in. calibre can be made to pierce completely armour plate up to 16in. in thickness, not merely normally, but even with the plate inclined at angles up to 20 deg. and even 30 deg. In one particular case a projectile fired at a velocity of about 1750ft. per second passed through a 12in. plate in 0·0039 second, and was recovered unbroken. The amount of energy absorbed was about 25,000 foot-tons. The most extraordinary point is that over a cubic foot of metal had to be got out of the way in less than half a hundredth part of a second! As Sir Robert points out, the significance of such results is not so much their importance in war, as the fact that the skill, experience, and equipment necessary to obtain them is available in times of peace for the manufacture of industrial products.

It is obviously impossible for us to refer at length to all that the members of the Iron and Steel Institute saw at Hadfields. Several books could be written about the works. Some "high spots," however, may be mentioned. In the main steel foundry—see the illustration on the opposite page—which is 1200ft. long and 7 acres in extent and is claimed to be the largest in the world, plaques representing Faraday standing in a metallurgical laboratory with a furnace to his left and a bench, chemical reagents and the now immortal box of "Faraday" steel alloys to his right, were cast in the presence of the members and turned out perfect in every respect. Faraday, as Sir Robert points out, had a considerable connection with Sheffield, and several of his alloys were made in the city. The steel plant, which includes modern types of open-hearth furnaces and a battery of electric furnaces in a range of capacities from 1½ to 6 tons, one of which is illustrated opposite, was examined with particular interest. The suggestion was more than once made that perhaps in the future electricity may come into use to such an extent that the need of Sheffield for innumerable chimneys will not longer exist. That time is certainly not yet, for such furnaces are only suitable for highly priced alloys. Near the fettling shops is the grinding department that deals with the "Era" manganese steel castings, which are so tough that ordinary machining methods are almost impossible. Not quite, however, for we saw in the machine shops a large casting in this material being turned, and it was observed that the metal appeared to be "torn" off rather than cut. The operation is illustrated by an engraving on this page. Owing to the exigencies of time, it was impossible to include the forging presses in the itinerary, but the steam hammers were seen, and the rolling mills, occupying an area of about 5 acres, aroused considerable interest, especially, on the "dramatic" side, among the ladies. There are three mills all electrically driven. The largest is a 28in. blooming and finishing mill driven by a motor rated at 3200 horse-power and capable of dealing with a transient peak load of 11,000 H.P. When running continuously this mill can turn out 1500 tons of billets and other sections a week, handling ingots weighing 1½ tons each. The others are 14in. and 11in. bar mills. The 28in. and 11in. mills are illustrated opposite. Tea, provided by the firm, was thankfully taken by the weary party before dispersal.

TURNING MANGANESE STEEL

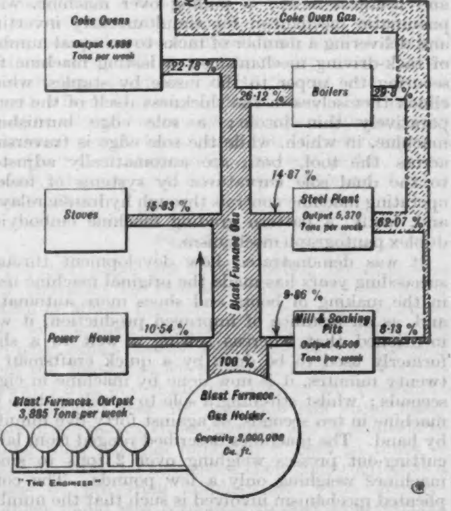
A long rest was not allowed them, however. At 7.30 nearly all gathered together again at the Cutlers' Hall for a banquet by the invitation of Sheffield industrialists. A quotation from Rudyard Kipling, made by Sir Robert Hadfield when proposing the toast of "The City and University of Sheffield," stands out in the memory :—

> "Gold is for the mistress—silver for the maid!
> Copper for the craftsman, cunning at his trade.
> 'Good,' said the Baron, sitting in his hall,
> 'But Iron—Cold Iron—is master of them all!'"

The words epitomise the attitude of Sheffield industrialists. To keep "Iron—Cold Iron" the "master" of them all, is their greatest concern.

On the following day, the last of the meeting, a special train left Sheffield at 9 a.m. to take the members of the Institute and their ladies to Scunthorpe. The London and North-Eastern Railway provided for this excursion the special new train we described in our columns on August 4th last. It is composed of open cars with tables on each side. Two seats—one might almost say chairs—are provided on each side of each table. The only criticism we heard made of the arrangement was that for a fat man the seats would be hardly wide enough. But men of such weight are in a very small minority. The riding of the coaches was all that could be desired. Arriving at Scunthorpe, two parties were made up; one, which we accompanied, to visit Lysaght Ltd., and the other the Appleby Iron Company.

The Lysaght works were originally built in 1912, but they have since been considerably extended. In our issues of July 22nd and 29th, 1932, we described fully and illustrated the coke oven plant, which has a weekly output of just under 5000 tons of coke, with the usual by-products of sulphate of ammonia, crude tar and crude benzole. As now arranged, the plant has become the first thermally balanced composite one in this country. There was none too much time in the morning available for the Iron and Steel Institute to see these works. A beginning was made by an examination of the blast-furnace plant. There are three small blast-furnaces, 18ft. diameter bosh by 13ft. 6in. hearth diameter by 70ft. high, and two larger furnaces, 20ft. diameter bosh by 14ft. 6in. hearth diameter by 75ft. high, the bosh angle being in all cases approximately 80 deg. One of the furnaces was being tapped at the time of our arrival, and the spectacular sight was much appreciated, particularly by the number of ladies that accompanied the party. The blast-furnace gas is conveyed from the furnaces to a large waterless gasholder with a capacity of 2 million cubic feet. A diagram reproduced herewith shows how it is subsequently used in conjunction with the coke oven gas.


Coke Oven. Gas Holder. Capacity 100,000 Cu. ft.
100 %
Coke Ovens Output 4,899 Tons per week
Coke Oven Gas
22·78 %
26·12 %
Boilers
29·8 %
14·87 %
Stoves
15·63 %
Blast Furnace Gas
Steel Plant Output 5,370 Tons per week
62·07 %
9·86 %
Power House
10·54 %
Mill & Soaking Pits Output 4,500 Tons per week
8·13 %
100 %
Blast Furnaces. Output 3,885 Tons per week
Blast Furnace. Gas Holder. Capacity 2,000,000 Cu. ft.
"THE ENGINEER"

FLOW DIAGRAM OF BLAST FURANCE AND COKE OVEN GAS

So that the furnace plant might receive the attention it deserved, the firm went to the trouble of providing every visitor with a slip of blue glass. There are seven fixed furnaces and one 160-ton tilting furnace, all of which are supplied with metal from a 300 tons gas-fired mixer. Three of the fixed furnaces, 60-tonners, are of the Terni type, one is equipped with Wellman-Soward ports and the remaining three are 50-tonners. All are heated by means of blast-furnace and coke oven gas, and waste heat boilers are fitted. Some of the men found the rolling mills somewhat too warm for their liking. There is a passageway between the 36in. cogging mill and the 32in. finishing mill, and when both are in action the heat thrown up by the metal is certainly somewhat overpowering. Steam engines of the three-throw reversing type drive the mills and the exhaust steam passes into a battery of Rateau accumulators for the purpose of generating electric power and blast for the furnaces. Semi-finished material in blooms, billets, slabs, and sheet bars is produced. After the inspection of the steel plant had been concluded visitors were conducted through the coke oven plant, which, as we have already mentioned, has been previously described in our columns.

Luncheon, at the invitation of Scunthorpe industrialists, in a great marquee erected in a field opposite the Lysaght works, was a welcome interlude after the exertions of the morning. Both the parties joined together for the function, and great admiration for the manner in which the affair was conducted was expressed. The weather, too, conspired to make the visit a success, for the sun shone brilliantly. After luncheon the greater number of visitors divided into the original two parties, the first, which had been conducted through Lysaght's in the morning, going to the Appleby Iron Company, and the second to Lysaght's. Others, however, preferred to go to the Frodingham Iron and Steel Company, Ltd., the Redbourn Hill Works of Richard Thomas and Co., Ltd., or the Scunthorpe Steel Foundry of Thomas Firth and John Brown, Ltd. We chose the last-named as a fitting corollary to the steel works of the morning. Being, comparatively to the extent of the other works small, it was, too, particularly agreeable for an after-lunch stroll! Erected in 1918 for the steel foundry plant of John Brown and Co., Ltd., it was decided after the amalgamation of that firm with Thos. Firth and Sons, Ltd., to concentrate the steel founding activities (with the exception of stainless steel casting) at Scunthorpe. This foundry is therefore adapted for producing a wide range of alloy castings. On arrival at the works the party was first conducted to the pattern shop, which, though small, is well adapted to its purpose. Thence we went to the main building housing the moulding, finishing, and heat-treatment departments, together with the fettling shop. It consists of four bays, the largest of which has a length of 750ft. by a width of 60ft. The first matter of interest to be seen was the centrifugal casting of railway wheels, which have a rim of tough manganese steel, the rest being softer. The complete operation was observed. Touring slowly through the foundry, moulding machines and sand preparation plant were examined. As, however, one of the three 2½-ton Robert acid side-blown converters was in action, there was a distinct tendency to give other matters less attention than they deserved. Besides these three converters which are fed by three cupolas, from which the iron is poured into a ladle for transference, there is also a 4½-ton Heroult electric furnace used for the more expensive alloys. Heat-treating furnaces with their tanks for oil dipping and water hardening were next observed, and the tour was concluded with a walk through the fettling and machine shops. In the course of conversation we heard the complaint made that the customer is seldom willing to take the advice of the steel foundry either in designing his patterns or in the composition of the alloys. The opinion was expressed that the customer would suffer less disappointment if he gave the steel founder a freer hand. In this connection the story was told of the engineer, who, having had some slight trouble with the products of a steel foundry, suggested in sending in a repeat order that since he believed it had a hardening action, a "pinch" of silicon should be added to the mix!

For the last time the party was gathered together at 4.30 for tea, subsequently breaking up, some to travel back to Sheffield in the special train, others to go to Doncaster for trains north or south. For ourselves the meeting concluded with leave-takings on the platform of Sheffield Station.

(To be continued.)

A MODERN COKING PLANT.

THE formal lighting up of the new by-product coking ovens which have been erected at the Manvers Main Collieries at Wath-upon-Dearne, near Barnsley, took place on Tuesday, September 19th. The plant, which was started up comprises thirty ovens of the underjet twin-flue type, complete with coal and coke-handling equipment, coke screening plant, and by-product recovery plant, designed and supplied by Simon Carves, Ltd., of Cheadle Heath, near Manchester. When completed, there will be in all forty-five ovens with a daily capacity of 1000 tons of washed slack. The present rated capacity of the thirty ovens will be about 500 tons per day, and the coke product will be specially applicable for domestic and central heating purposes. The by-product installation includes two stills with a designed output of 10,000 gallons of motor spirit, and it is expected that between 3,000,000 and 4,000,000 cubic feet per day of surplus gas will be available for supply to local authorities for town lighting and for industrial uses.

The British Association.

No. II.

(*Continued from page 256, September 15th.*)

THE work of the Safety in Mines Research Board was the subject of an evening discourse to the members of the British Association on Monday, September 11th. It was accompanied by experiments and a cinematograph film.

Professor J. F. Thorpe, F.R.S., the lecturer, said the Safety in Mines Research Board is appointed by and reports to the Secretary for Mines, and is financed liberally from the Miners' Welfare Fund. Its experimental work is carried out at two research stations, viz., at Harpur Hill, Buxton, and Portobello-street, Sheffield, where it is in close association with the Department of Applied Science of the University. Both these research stations are under the direction of Dr. R. V. Wheeler, to whom Dr. H. F. Coward is Assistant Director. Falls of roof and haulage accidents are investigated by Major Hudspeth, Chief Mining Engineer to the Board. It was also mentioned, by way of introduction to the lecture, that the Board also works through a number of sub-committees of which the Explosives in Mines Research Committee, the Spontaneous Combustion Committee, and the District Support of Workings Committees, may be regarded as types.

Commenting on the importance of the work of the Board in regard to mine safety, Professor Thorpe pointed out that by far the greater number of casualties and fatal accidents in coal mines during the period 1922–31 were due to falls of ground and haulage accidents. Persons killed through explosions during that period numbered 521, whereas the deaths due to falls of ground and haulage accidents were 5199 and 2276 respectively. Nevertheless, the casualties due to the two main causes just named were mainly adventitious, and it was difficult to subject them to scientific as distinct from human control. On the other hand, the causes of explosions and their elimination could be made the subject of scientific investigation, and the fact that the terrible disasters of the past no longer occurred must be ascribed to the application of the knowledge which had been gained by scientific research and investigation.

The lecturer than described the way in which that has been done, and showed the many causes which might lead to the ignition of gas and the methods which were being taken to remove those causes. The experiments had been arranged at the Board's Sheffield Research stations by Dr. H. F. Coward and three members of the staff of the Board—Messrs. Hartwell, White, and Russell—were in attendance as demonstrators.

Briefly recounting the conditions of work in coal mines, Professor Thorpe said that explosions could be caused either by gas or coal dust, indicating at the same time how fire-damp was evolved from decaying vegetable matter—a process of bacteriological fermentation. He also explained that coal dust, if fine enough, formed explosive mixtures with air as dangerous as, or, in some respects, more dangerous than mixtures of fire-damp and air. Although little by little the various causes of explosions, of the initial ignition of fire-damp or coal dust, had been recognised and controlled, the aim necessarily was to eliminate them completely. Fire-damp was only explosive, however, when mixed with certain proportions of air, between the lower limit of about 5 per cent. and the upper limit of about 14 per cent. Good ventilation of the mine, therefore, was a primary safeguard against fire-damp explosions, and that had resulted in stringent regulations governing ventilation. At the same time, should the ventilation be defective, there were many potential means of ignition of fire-damp in the pit, such as lights, explosives, electricity, frictional sparks, and so on, and they all had to be provided against. Consequently, much of the experimental work on safety in coal mines that was being carried out in this country and abroad was directed towards safeguarding all possible means of fire-damp ignition.

Coal dust, which, during one period in the history of coal mining, constituted the more formidable danger, could be rendered harmless as an explosive agent, and credit for the discovery, and certainly for the practical application of the remedy—stone dust—was due to a Yorkshire mining engineer, the late Sir William Garforth. Although, however, the spreading of fine stone dust in a coal mine appeared simple, it was complicated by the fact that there was not a dead level of inflammability of coal dusts. Some coal dusts were much more inflammable than others, and required to be treated with a proportionately greater quantity of stone dust before they could be regarded as harmless. Wise mine managers treated the roadways of their mines with a quantity of stone dust considerably above that required by the regulations, and it could be said with some confidence that in this country the wide-spread disasters caused by coal dust extending small fire-damp explosions throughout the working of the mine, such as occurred in 1905–12, need no longer be feared.

Often enough, concluded Professor Thorpe, before proceeding with his experiments, the application of a remedy against an accident rested with the miner. Therefore, it was necessary to instruct the miner—who had shown himself willing to be instructed—as to the reasons for measures of safety—sometimes arduous—that he was called upon to perform, and as to the risks he ran if he neglected them. For that reason, the educational work of the Safety in Mines Research Board ranked equal in importance with its experimental work.

The experiments which followed included the propagation of flame in methane-air mixtures; the inflammability of coal dust and the effect of stone dust thereon; the ignition of methane in air by a heated surface and the effect of iodine on the ignition temperature; the ignition of fire-damp by heat of impact of handpick on rock; signalling with bare wires; clay and sand-clay stemmings; lamp testing; an experiment showing that a lighted cigarette does not ignite a 6 per cent. methane-air mixture, and illustrations of spontaneous ignition by means of pyrophoric iron.

The films showed a demonstration of a coal explosion at the Buxton research station and shot firing with clay stemming and sand and clay stemming. Finally, a number of lantern slides were exhibited showing total casualties in coal mines; total fatal casualties; and the effect of stone dusting on casualties due to explosions.

SHOE MACHINERY.

The first paper in Section G on Tuesday morning, September 12th, was by Mr. Joseph Gouldbourn, of the British United Shoe Machinery Company, of Leicester, and dealt with shoe-manufacturing machinery and some special problems in its design. The paper outlined the comprehensive character of the machinery and summarised categories of special machines developed for performing certain important operations of the many different kinds into which the manufacture of boots and shoes has become divided. In illustration of the peculiar problems which the designer has had to solve, special attention was called, for instance, to a stitching machine which will set a lockstitch reliably at a selected depth in a sole as much as ¾in. thick, while sewing 1000 or more stitches a minute; metallic fastening machines, comprising means for marshalling and delivering both headed and headless nails; a pulling over machine, with pneumatic mechanism for simultaneously inverting and delivering a number of tacks to an equal number of tack-driving mechanisms; a lasting machine for securing the upper to the insole by staples, which clinch themselves in the thickness itself of the comparatively thin insole; a sole edge burnishing machine, in which, while the sole edge is traversing across the tool, both are automatically adjusted to the dual sole curvatures by systems of feelers operating machine controls through hydraulic relays; and, lastly, a pattern grading machine embodying duplex pantograph mechanism.

It was demonstrated how development through succeeding years has made the original machine used in the making of boots and shoes more automatic, and, as an instance of improved production, it was mentioned that whereas sewing a welt to a shoe formerly used to be done by a quick craftsman in twenty minutes, it is now done by machine in eight seconds; whilst stitching a sole to a welt is done by machine in ten seconds, as against forty-five minutes by hand. The machines described ranged from large cutting-out presses weighing over 2 tons to small machines weighing only a few pounds. The complicated mechanism involved is such that the number of parts ranges from 1500 to nearly 3000 per machine.

Mr. William Taylor said that as the directors of the British United Shoe Machinery Company were modest men, perhaps he might give a little sketch of the development of the business of that company. When he himself first went to Leicester in 1887 there was a firm known as Pearson and Benyon, Pearson being a most ingenious designer of machinery for making boots and shoes. Benyon was also an engineer, who was trained under Webb at Crewe, but generally he was responsible for the organisation of the business of Pearson and Benyon, and together with Mr. Pearson had transformed the whole process of making boots and shoes. The result was that the firm at the present time made the majority of the machinery used in the industry, not only in this country, but in the Colonies and some other countries. When he first knew the shoe industry it was in a very primitive state, the operators working on the floor among all sorts of scraps of leather and rubbish, without any bench, and when one compared that state of affairs with the present modern boot and shoe-making factory, it should be remembered that the change was largely due to the work of mechanical engineers and the work which was originated by Pearson and Benyon. There came a time when Benyon went to America, and realising that certain machinery which had been patented by the Americans was vital to the industry, he linked his firm up with the big American Shoe Company, and since that time the company in this country had been a branch of the American concern. A glance round the factory of the British United Shoe Machinery Company reflected the genius of Mr. Pearson and his partner, and demonstrated the tremendous number of fundamental problems that had to be dealt with in the design of boot and shoe-making machinery.

UNEMPLOYMENT PROBLEMS.

Three papers were then read and discussed together, all of them relating directly or indirectly to unemployment.

Professor Miles Walker, under the title "Great Engineering Works of Profit as a Cure for Unemployment," dealt with some engineering projects which, he said, promised a fair return and would employ hundreds of thousands of workpeople. He also considered methods of finance, similar to those proposed in America, for enabling the people to purchase the things they had made or for contributing to the cost of the future wealth-producing projects.

Many of the proposals made in the past for the cure of unemployment, he said, entailed the expenditure of large sums of money on public works, such as road improvements and new parks. The first consideration in the minds of those who proposed those works was the spending of money so that wages might be paid to those brought into employment. The second consideration was the choice of some work which (but for the present urgency of finding employment) would probably be done at some future date. It was argued that in choosing the work to be done, we must not put someone else out of work. That way of looking at matters was entirely wrong. The main object should be to create as much wealth as possible with the least expenditure of money, and instead of employing as many men as possible on some particular job, one should employ as few as possible on that job, there being no limit to the number of men who could be employed, because there was no limit to the work waiting to be done.

The raising of money by loans or taxes to do work that was not pressing had the effect of increasing unemployment, because it took money from people who would otherwise spend it on things they wanted and put out of work the people who ordinarily would supply those things. Instead of getting real wealth (*i.e.*, things we needed), we got only prospective wealth, which we could not use immediately.

The work to be chosen in order to create real wealth could be divided broadly into two classes:—

(1) The manufacturing of machinery and facilities for creating the articles we needed; and (2) the manufacture of the articles needed.

Coming to the effect of our monetary policy on unemployment, he said that some people were in favour of inflation and some of deflation. In his opinion, sufficient emphasis was not put upon the difference between wise and unwise inflation. Money could be replaced by paper receipts for work done. When a Government printed money and paid it out in order to carry on a war or to carry out relief work which did not produce real wealth equivalent to the money spent, it was unwise inflation. When a Government, in order to get going large numbers of unemployed inhabitants upon work which created the wealth they needed, printed promises to pay for work done, it was wise inflation. Under good management, the promises could be redeemed by giving the worker the things he needed; and by the use of machinery and economical production it was possible to give to the worker a greater return for his labour than could now be bought for the money usually paid in wages. It did not matter how much paper money of that kind was printed and circulated, so long as the amount of permanent wealth created was as great as or greater than the equivalent of the money issued. None of the money need be permanent; it could be destroyed as soon as the promise to pay was redeemed by the delivery of the goods.

It had been obvious to all sensible people during the last fifteen years that the right cure for unemployment was to set the people to make all the things they lacked. But the blindness of those who controlled the situation had prevented even that most obvious solution being inaugurated. Had the control been in the hands of engineers, it was exceedingly probable that during the few years following the war the manufacture of all the things wanted by the people would have been started in this country and in the Colonies on an immense scale. Mass production methods would have been improved to such an extent and overhead charges reduced to such a small fraction of the total cost that we should have been able to sell all kinds of machinery and household utensils at low prices to the rest of the world. By setting them an example, we should have taught them to manufacture more of their own wealth, and, by whetting their appetite, given them the desire and ability to buy from us goods that they could not make themselves.

We had spent 200 millions on public works which had not appreciably increased our present wealth, and we were paying interest on the money borrowed.

The best alternative to that method was to carry out the plan he had outlined. But it might be difficult to absorb at once two and a half millions of people on activities directly connected with the production of their own immediate wealth. We must take a rather longer view, so as to comprise in the word "wealth" engineering works which prepared for an ever-greater production in the future of the things the people needed.

During the last twenty years many sane engineering projects had been brought forward—underground railways in large towns, river bridges, extensions of electric power generation and transmission, the change from tramways to Diesel-driven omnibuses, the change from steam-driven to Diesel-electric locomotives, especially of the type containing torque-conversion apparatus, on main line railways. In many cases the possibility of a large margin of profit could be shown; in many the margin of profit was not sufficiently enticing to stir the people to action, but under the right methods of finance the work could be usefully carried out.

Professor Miles Walker then discussed the openings for the manufacture of plant for the carbonisation of coal and the hydrogenation of coal products in Lancashire; a world demand for oil-engine-driven locomotives; the development of underground railways in our large cities; and the desirability of erecting a building 800ft. high on the Piccadilly site in Manchester. A building of that kind, he said, would have cost about three millions sterling, practically the whole of which would have been spent in the neighbourhood on steel stanchions, girders, and other building materials, so that Manchester, by using her unemployed and saving the dole, might have said that she obtained the building for nothing. The upper stories would have housed comfortably about 10,000 people under the most ideal conditions. The ventilating plant would have drawn in the air from a point 800ft. above sea level, and supplied all the occupants with fog-free air at a suitable temperature all the year round. The cubic capacity of that building would have been so enormous that it could have housed also the picture gallery and free library, and there would have been also valuable sites for shops all round on the ground floor. The return from rents, on the most reasonable basis, would have been more than £450,000 per annum. Thus, Manchester would have relieved unemployment, solved the housing problem for 10,000 people, provided a free library and picture gallery, obtained the building for practically nothing, and secured an income of nearly half a million sterling for all time. In addition, pictures of the beautiful building would have been published all over the world and advertised Manchester as a go-ahead town.

He referred also to Mr. William Walcot's project for straightening the bed of the Thames in London and utilising the present bed in a profitable manner; and the project for the utilisation of the space over our railways. That was engineering work mainly, as it would call for the manufacture of millions of tons of stanchions and girders. It would improve London architecturally, and provide splendid arterial roads.

LAND RECLAMATION.

"Sea Defences and Reclamation of Land from the Sea" formed the subject of the next paper, the author being Mr. M. Du-Plat-Taylor. It dealt with the subject from two aspects—(1) the protection of lands against the inroads of the sea, and (2) the reclamation of lands from the sea, both of which, said the author, were worthy of consideration at the present time from the point of view of the relief of unemployment.

Speaking of sea walls and breast works, it was pointed out that the type of wall with a vertical face was most unsatisfactory, because it was liable to be undermined by the undertow or backwash of the waves, and, therefore, it must have deep foundations, which resulted in its cost being nearly three times that of the stepped wall. The latter and more modern type of sea wall either consisted of a sloping wall or a stepped wall constructed of reinforced concrete and so designed that the energy of the waves was gradually dissipated and the water finally turned back towards the sea. Walls of that type had been adopted for protecting stretches of open coast, because they were actually not much more costly to construct than earthen embankments and were much less costly to maintain.

Dealing with reclamation of lands from the sea, a number of well-known instances were mentioned and the economic aspect was discussed to some extent. For instance, in the case of the reclamation by the Dutch Government of 555,000 acres of land in the Zuyder Zee, at a cost of approximately £60,000,000, or £108 per acre, it was pointed out that the amount realisable from the sale of those lands for agricultural purposes could not possibly recoup the Dutch Government for the capital expenditure, but in that case the scheme was regarded as a national undertaking which would provide accommodation and occupation for the expanding population. If the increase in trade and taxable values was taken into account, it might turn the scale.

Owing to the agricultural depression no reclamation scheme intended to provide agricultural land only could now succeed in this country, said Mr. Taylor, but reclamation for industrial purposes or for the combined purpose of disposing of some waste material and the provision of additional land fell in a different category. For instance, a large scheme of reclamation in the estuary of the river Tees had recently been carried out by the Tees Conservancy Commissioners by which an area of 267 acres of land on the Seal Sands was being reclaimed, by pumping on to it the material arising from dredging operations for widening and deepening the river channels. That scheme would provide industrial sites. The Dublin Port and Docks Board was carrying out reclamation to provide industrial sites on the north side of the channel by pumping sand dredged from the harbour and channels on to an area of about 80 acres.

Speaking of the cost of reclamation a figure of £15 to £30 per acre was mentioned as applying to some of the earlier schemes of the eighteenth and nineteenth centuries, where the area was enclosed and the water pumped or drained out, but at the present time in the most favourable circumstances the cost, he considered, to be more likely not less than £70 per acre, or even £100 per acre, without pumping. In the case of the Zuyder Zee the cost of the permanent works had been over £100 per acre apart from the cost of the initial dewatering and drainage pumping. The method of reclamation by enclosure and pumping was generally only suited to the provision of agricultural land which could not be brought into full cultivation for two years. The second method of reclamation, namely, by filling, could, however, yield a substantial profit. Areas flooded by the tides might be enclosed and the level of the land raised by depositing waste material on it, such as furnace slag or colliery waste. In that connection the author drew attention to the enormous quantity of dredged material which was deposited in the sea every year, and suggested the possibility of utilising it for reclamation purposes. For instance, the quantity dealt with annually by the Port of London Authority was 4 million tons, and whereas the cost of dumping at sea might be as much as 1s. 9d. per cubic yard, the cost of pumping ashore to a moderate distance with a reclamation pumping plant would not exceed 1s. per cubic yard, and often very much less.

Finally, Mr. Du-Plat-Taylor drew attention to the disposal of house refuse and sewage sludge in relation to reclamation schemes. In London 1,500,000 tons per annum of house refuse was disposed of by dumping it in great heaps upon land and burning it, the average cost of such disposal being 7s. 6d. per ton. Moreover, 3 million tons of sewage sludge was annually sent to sea from London to be dumped in deep water from hopper barges. It should not be impossible, however, to devise some means of disposing of this huge mass of material to a better advantage by using it to reclaim muddy foreshores and low-lying marsh lands in the Thames Estuary, making them suitable for agricultural purposes. It would, of course, be undesirable and useless to cover the land with a solid layer of wet refuse or sludge to a depth of 10ft. or more, but if the disposal of those materials was combined with that of dredged material it would be possible to deposit the refuse or sludge in a layer, say, 2ft. thick, and then blanket it with a layer of dredged clay or sand. That process could be carried out in alternate layers, finishing with a surface layer of clay or sand. Mr. Taylor recognised the objection to that scheme, but said he felt, nevertheless, that it was one which deserved further investigation.

SHIP CANALS.

The third paper was by Mr. Walton Maughan, and was presented by Professor Holman, of the Royal School of Mines, London. The object of this paper was to stimulate interest in the construction of shipping canals across this country—for instance, from the Mersey to the Humber, from the Tyne to Solway Firth, and from the Clyde to the Forth. It was explained that Mr. Maughan had spent many years investigating these schemes, and in addition to urging their national importance, both in times of peace and war, he advocated their construction as a means of providing employment. The Mersey–Humber Canal was estimated to cost £140,000,000, the Tyne–Solway Canal £36,000,000, and the Forth–Clyde Canal £52,000,000. It was suggested that these canals should be sponsored and controlled by the railways jointly, a special Transport Board being set up for the purpose. Another feature stressed was the great advantage they would have by diverting a large proportion of the ultra-heavy traffic now carried across country and to that extent would reduce expenditure on road maintenance. In support of the proposals, reference was made to the White Sea–Baltic Canal, which had been built by the Russian Government in the record time of twenty months; in that case, however, by forced labour. That canal is 227 kiloms. long. Reference was also made to the great development of the canal systems on the Continent in justification of the large expense which would be involved. Incidentally, the idea is to have these canals wide and deep enough to take battleships and, of course, ocean-going liners.

The President (Mr. R. W. Allen), in thanking the authors of the paper, reminded those who favour canals that the whole problem with such schemes was finance, and he doubted whether any schemes, however they might appeal as regards the relief of unemployment for the time being, would have a chance unless it could be shown that they were financially sound.

Commissioner Lamb, of the Salvation Army, who was called upon by the President, discussed Professor Miles Walker's paper, and expressed his regret that an engineer should have brought engineering into the realms of high finance. For goodness sake, he said, let engineers keep out of high finance and get on with engineering. Speaking generally on the proposals in the paper, he expressed the view that a better service to the nation would be done by concentrating upon overseas settlement rather than by spending large sums of money on works in this country which would only have the effect of keeping the present large population within these shores. Unless we took full advantage of the possibilities of overseas settlement, this country would be overwhelmed. Commenting on the remark by the President of the Association in his Presidential Address that science was one of the humanities, Commissioner Lamb said he hoped that soon humanity would become one of the sciences.

Captain W. N. McClean remarked, as regarding reclamation schemes, such as that of the Wash, that a point always to be borne in mind was the flooding of the rivers, and it might be that by giving extra capacity for the outlet of floods from rivers in the reclamation scheme, very considerable improvement might be effected from the flooding point of view. Generally speaking, water transport was considerably cheaper than rail transport, but he was not aware over what area of country that applied. After mentioning a case in which coal was carried by canal 40 per cent. cheaper than by rail, Mr. McClean commented on the manner in which road transport was competing with railways even in the transport of coal, owing mainly to the time taken in the return of trucks, which was usually seven or eight days, and from that standpoint one 5-ton lorry would carry as much coal, in a given time, as seven 10-ton railway trucks. Finally, he expressed doubts as to whether a big expansion of canals would be of any particular advantage to the country.

Mr. J. S. Wilson (Recorder, Section G), speaking of another form of reclamation, namely, carrying roadways over railway cuttings in populous areas, mentioned an instance in London where the cost of covering such a cutting amounted to the equivalent of £93,000 per acre, *i.e.*, £2 3s. per square foot, including all road surfacing, &c. Those figures were arrived at when costs were higher than at present, and possibly the figure to-day might be 30s. per square foot or £65,000 per acre. Such figures did not make such proposals very feasible.

Colonel E. R. Pratt, agreeing with the general principle that any works of the nature suggested in the papers must be productive, disagreed with the implication in Professor Miles Walker's paper that the efforts so far made were not in that direction. For instance, the electric "grid" was a great step forward in productive works, as also was the construction of wider and straighter roads throughout the country. At the present time it was possible to get money in London for developments in Rhodesia or Uganda, but not in this country, unless the profits were so great that they brought with them the risk of penal taxation. Frankly, concluded Colonel Pratt, he did not think any of the authors had produced a new suggestion which would help very much.

Mr. W. Maughan, in reply to the discussion, contended that the canal schemes he had suggested would be economically sound, and he based that view on the fact that water transport generally was much cheaper than road or rail transport.

Professor Miles Walker, whilst agreeing with Commissioner Lamb on the desirability of overseas settlement, said that was a question quite outside any engineering problem. He added, however, that he was in entire disagreement with Colonel Pratt that we should continue with such projects as the further development of roads now, because in his view we could not afford them, and must wait until times were better. At the present time the unemployed wanted houses, furniture, clothing, food, &c., and they should be set to work to make those things, because the wages earned would be put into circulation and stimulate industry in many directions.

Mr. Du-Plat-Taylor agreed that the cost of dredging and dumping would vary according to the conditions and said that the figures in his paper related to the case he had mentioned. Strictly speaking, reclamation had no effect on the question of the flooding of rivers, because each area should have its own drainage for removing the surface water, and so long as the channels were properly cleared there should be no difficulty from flooding.

The President, commenting on the remarks of Commissioner Lamb, assured him that every engineering project is inevitably bound up with high finance, and cannot be separated. It was always one of the most important considerations for the engineer. As to humanity becoming one of the sciences, he also reminded Commissioner Lamb that engineering and other employers to-day regarded the welfare and conditions of their workpeople as a first consideration. In that connection he mentioned the infinitesimal risks obtaining to-day in the case of men working under high-pressure for tunnelling work. He assured Commissioner Lamb that engineers, on the one hand, were bound up with finance, and, on the other hand, had one great object in view, namely, humanity.

(*To be continued.*)

Must Science Ruin Economic Progress ?[*]

By SIR JOSIAH STAMP, G.B.E.

ECONOMIC progress is the orderly assimilation of innovation into the general standard of life. It usually connotes a widespread sharing of new benefits, but is by no means inconsistent with some degree of uneven distribution of wealth or income, for in a non-socialistic community some disparity generally raises the standard of life of the mass to a point higher than it would be under a forced equality of distribution of wealth, the envies caused by disparity notwithstanding. The purely material standard in Great Britain was raised fourfold during the nineteenth century, and probably rather more in the United States. If we take into account also length of life and proportion of leisure, the increase is much greater. The improvement arises only to a very small extent in changes in the average innate capacity of man, not co-operant with, or parasitic upon, his environment. It is almost all due to innovation in social activity (including social education and the reactions of economic betterment upon physical and mental ability). The greater part of the innovation is scientific innovation—in physics, engineering, and public health—but a not inconsiderable part falls outside these categories, and belongs to the non-physical section—better ideas about money, more social confidence in banking and credit, improved political and social security, and legal frameworks for the better production and diffusion of wealth. The elaboration of these factors depends partly on intellectual prevision and invention, but mainly upon average moral standards, and calibre of character, since many political schemes, including international co-operation, are impracticable only because of failings in the present standards of human nature.

It is being commonly stated that scientific changes are coming so think and fast, or are so radical in their nature and implications, that the other factors of social life, the intangibles of credit, the improvements in political and international organisations and ideas, are unequal to the task of absorbing and accommodating them, or else they present new problems which have no counterpart. If changes in social forms and human nature or behaviour cannot possibly be made rapidly enough for the task, then in that sense science may " ruin " economic progress, and the world might be better served in the end if scientific innovation were retarded to the maximum rate of social and economic change.

Civilisation went through a long period when the limiting factor to progress was the scientific, but is now passing through a stage when the limiting factors are non-scientific. The lack of identity in the *tempo* of change creates new problems, tending to offset scientific advantages, of three types. First, for example, the utilisation for essential or competitive purposes of rare minerals, the need for which becomes general, but the distribution of which is particular and accidental, sets up great political strains, and we have invented no means of adjusted the international effects of accidental monopoly of essential elements. Secondly, the problem of scope, where the scale of production upon which, for example, a chemical innovation can be made to give its real economic advantages, is a scale inconsistent with the size of markets freely open in a nationalistic world. Here strains are set up in the international machine and the balance of trade, which may gravely jeopardise economic progress and dry up the juices of commerce. Thirdly, for example, where the innovation is absorbed most easily for offensive purposes in a military or naval sense, it may create rivalries and changes of balance of power inimical to economic security, and compel new economic sacrifices outweighing the direct economic advantages of peaceful uses. It is open to question whether the innovation of aircraft has yet become, on net balance, economic progress.

Inasmuch as all economic production creates real vested interest in a location or a skill devoted to it, and every scientific innovation alters the centre of gravity of collective demand, every such scientific change disturbs an economic equation. That equation for human life may often be richer ultimately, but the pain or waste of disturbance has to be debited to the gain, before the net balance is progress. For the time being, the balance may be net loss, the price paid for to-morrow. If to-morrow is continually postponed, because it, in its turn, is re-disturbed, and the economic to-morrow never comes, it is " jam yesterday, jam to-morrow, but never jam to-day." Wastes of absorption will be at a minimum in certain conditions, which are related to the wearing life of existing assets and places, and to the rate of flow of new skill into new directions.

The orderly absorption of innovation into economic process, apart from improvements in the non-economic factors of such progress, depends upon two kinds of balance. The first is the balance between two classes of scientific discovery, that which accelerates or makes easier the production of existing economic goods, and that which creates new kinds of economic satisfactions—the derivative and the direct. Let us suppose that in a static society a million people are employed making boots, and the gramophone has not been invented. Then let a labour-saving device be invented, such that the same quantity of boots can be made by half the workers, and boots are half the price. Assuming that the demand for boots is quite inelastic, and no more are wanted, there is potential unemployment for half a million people, and the whole population has now reserve unspent purchasing power, saved on cheaper boots. The gramophone is introduced, employing the potentially unemployed, and absorbing the reserve or released purchasing power.

The progress of the past hundred years has been essentially of this order, and innovation has enabled purchasing power to be released for new spending, first upon far *more* of the same article at the reduced price ; secondly, upon more of other existing goods ; and, thirdly, upon entirely new kinds of satisfaction, such as bicycles or radio sets. In this connection it must be remembered that an old article may be so transformed in degree as to be equivalent to a change in kind—the silk stocking and feminine footwear are cases in point. Now even if these two classes of innovation, direct and derivative, are in balance, the process of absorbing them will give rise to economic " growing pains " and temporary dislocations of capital and employment, but the gains will rapidly outweigh the disadvantages. But when they are not in balance, the process is more painful, and the debit to be set against progress very much greater.

The introduction of machinery has been for three hundred years accompanied by the same hostile arguments, for the immediate effects in unemployment are much more obvious and human than the countervailing employment given by the released purchasing power, which may occur in some other place or country. Illustrations may be found all the way from Queen Elizabeth's sentiments on stocking-knitting machinery to the Luddite riots, and the eight looms per weaver of to-day. But in the literature of the whole series, nothing can outdo, for detailed economic jeremiad and precise calculation of woe, a contemporary examination of the effect of the introduction of the stage coach in the middle of the seventeenth century upon the post horse industry and all that depended upon it (" In Grand Concern of England," 1673).

The argument so far, no doubt, begs the question of the meaning of progress, and assumes that silk stockings and fine shoes represent a " higher " standard of life than black, homespun woollens and rough boots—a doctrine that is not acceptable to Mr. De Valera, for example—but as we are not entering the field of morals or ethical aims, we are obliged to assume that those objects which are actually the subject of average human desire must be given their economic significance accordingly, and not attempt to solve the larger problem simultaneously. In this sense such a mechanical invention as the totalisator must take its place in " progress " at this stage.

The problem of balance, in the direct and the derivative, is not, however, so simple in practice, for the sum total of the effect of derivative innovation (creating technological unemployment) ought to be balanced by the sum total of direct innovations or increased demand for other products (new and expanded employment). But many direct innovations are not additive ; they are substitutional, and destroy the need for old commodities. If combs are made from celluloid and dishes from *papier mache* or pyrex, they will certainly not create a wholly additional demand or employment—there will be a displacement of the old types in metal or bone combs or china dishes. This substitution goes into rival classes of utility also, and a radio set may be a real substitute for a billiard table, and oil may be the enemy of hops, if cheap bus-riding supplants long sittings in public houses. These substitutions may be gradual enough to be absorbed as a normal feature of progress, but if they are very rapid and coincide with certain other economic disturbances, they may be very distressing. By " normal " I mean such as can be coped with by the direction of new labour entering industry or new capital spent on renewals, leaving the contractions to take place by natural age attrition without unemployment or by premature obsolescence—for the moment, this is the optimum point of change.

The lack of balance between derivative and direct innovation may be due, of course, to a terrific drive and rapidity in scientific recovery of the industrial type, but it is only fair to say that the excess of one may be due to causes on the economic side. If for purely monetary reasons, the gold standard, &c., the purchasing power of money is continually increasing through falling prices, and, with the current inability to change the money totals of wages and other costs, real wages are rising, it becomes increasingly possible to substitute innovations of machinery for hand labour or complex for simple. A change that was not worth making on a balance of old wage costs against new capital costs in 1923, became well worth making by 1932, and indeed imperative, if any profits were to be preserved. Hence the almost artificial pressure which a rigid monetary system may bring to bear towards the over-rapid application of new methods and creation of unemployment.

The second kind of balance which is vital to economic progress and may be ruined by over-rapid innovation is that between obsolescence and depreciation. Nearly all scientific advance for economic progress has to be embodied in capital forms, to be effective, more and more elaborate, large and costly. The productivity of such apparatus and plant per man involved becomes greater, and even allowing for the men employed in making the machinery or process, the total satisfaction is continually produced with less and less human effort. Now it used to be said of British machinery that it was made good enough to last for ever, and long after it became old fashioned, whereas American machines were made to be worn out much earlier, and were thus cheaper, but could be immediately replaced by capital assets containing the latest devices. If the period of physical life and fashionable life can be made to correspond, there is greatest economy and security of capital. But if the expensive embodiment of the latest science can be outmoded and superseded long before it is worn out, there is waste of capital, loss of interest, and resultant insecurity of business and investment.

The factor of physical safety alone means that each embodiment must be really durable, even if roughly finished, and therefore it is impossible wholly to reduce physical life to probable " obsolescent " life. In this way an over-rapid series of innovations may mean the scrapping or unprofitability of much excellent capital for very small marginal gains. A responsible socialist community would see each time that the gain was worth while, but competitive individuals have no collective responsibility. Suppose the giant Cunarder attracts a profitable contingent for two years only, when a lucky invention in a new and rival vessel attracts all her passengers at a slightly lower fare. Here is progress in one typical sense, but the small net advantage to be secured by individuals as free-lance *consumers* may be dearly purchased by large dislocations or loss of capital reacting even upon those same individuals as *producers*. Now, if the innovation were very striking, and were reflected in working costs, the margin of difference between the old working costs and new working costs may be large enough to pay interest on the new capital employed and also to amortise the cost of the unrealised life of the asset displaced. A locomotive may have many years of useful life left, but a new type *may* provide a margin by lower working costs not only sufficient to make one adopt it on normal renewal, but also to pay for the premature scrapping of the old type.

The majority of modern innovation is, however, of the type which does *not* pay the costs of obsolescence and proceed by orderly and natural physical renewal or substitution. A similar type of argument applies to the capital expenditure generally on a district, which can be amortised over the economic activity of that area, such as a colliery area, but which is wasted if a dislocation occurs by the adoption of some innovation stimulating rival activity in another place. Similar but more poignant considerations apply to obsolescence in human skill and training, more rapid than the ordinary attrition through age retirement can accommodate. Physical capital forms, human vocational training, and centring in geographical areas, are all essential features in the absorption of scientific innovation into economic progress. Each has its *natural* time span, and a narrower span of scientific change is bound to set up large economic debits to be set against the economic credits of the change. A man running a race might be stopped to be given a new magic cordial which, *after* allowing for the two minutes stoppage, would enable him to finish a minute earlier. But if he is stopped at frequent intervals for other magic cordials, each advantageous by itself, the total period of stoppages would at some point exceed the possible gains of speed during the short undisturbed running periods, and he would finish later at the post, instead of earlier. This is a parallel to the current effects of too rapid disturbance on progress.

Under an individualistic form of society, it is difficult to alter the social technique of change, and to make its credits really pay for the debits, and make all the people who gain by the profits on new capital pay also for the losses on prematurely displaced capital, or the gainers by cheapness and variety pay the human costs of unemployment and the skill no longer wanted. The *basic* economic reason for social unemployment relief is not the humanitarian argument of social obligation against distress, *or* the argument against revolution, but the plain argument that the gainers by innovation should bear the losses of innovation.

At the same time, much can be done to shorten the hitherto natural time span and make society ready to absorb the quickened tempo of science. No prices ought to be charged except on the basis of costs fully loaded with short-period obsolescence—this would prevent over-rapid substitution, economic only to a narrow range of people. We have no adequate technique of change ; we treat life as mainly static, with occasional and exceptional periods of change, whereas we must learn to look upon it as continuously changing, with occasional and abnormal periods of rest, and we have to secure all the changes of social outlook implied by that reversal of view.

The next field in which scientific advance alters the economic problem faster than we can solve it is in the duration of human life. We have to provide a social dividend adequate to maintain a much larger proportion beyond the age to contribute to it. Combined with the altered birth-rate, a profound change is taking place in age densities, and the turnover from an increasing to a stationary, and then a declining population, in sight in Great Britain, Belgium, Germany, and even the United States, is bound to affect the *tempo* of economic life. A larger and more immediate problem of adjustment is, of course, the absorption of the results of science not in increased masses of new kinds of commodities made by the released labour of labour-saving devices on old kinds, but in generalised leisure. The transition from a state of affairs in which we have an uneconomically high commodity wage paid to a part of the population, and the rest with a mere pittance and enforced idleness, to a state where a part of the reward is taken *all round* in larger leisure, and where economic satisfaction from leisure is deliberately equated to that from commodities in the standard of life, may need a surgical operation or a catalyst, such as the United States experiment can show.

In the past, the absorption of innovation has been achieved, according to contemporary explanation, by four agencies :—(1) Great elasticity of demand for the old commodities at reduced prices, food and staple household necessities ; (2) rapid introduction of new things ; (3) the rise in population *created* by the increase in produce ; (4) overseas outlets in more backward industrial countries. In the first the elasticity completely alters as the standard rises, and generally there is not now the scope for lower price in food or clothing increasing the demand *pro tanto* ; for the third, a rising standard no longer stimulates population but tends the opposite way ; for the fourth, the external outlets are now largely self-producers. As regards the rapid introduction of new things—those mostly now demand increased leisure for their proper absorption and use, so that the two are corelated and mutually dependent.

It can be conceived that a socialistic organisation of society could obviate such of the maladjustments as depend upon gains and risks of absorption not being in the same hands, and a theoretical technique can be worked out for the most profitable rate of absorption of scientific invention, having regard to invested capital, and skill and local interests. It is sufficient to say that it needs a *tour de force* of assumptions to make it function without hopelessly impairing that central feature of economic progress, namely, individual choice of the consumer in the direction of his demands, and an equally exalted view of the perfectibility of social organisation and political wisdom. But in the field of international relations and foreign trade, which alone can give full effect to scientific discovery, it demands qualities far beyond anything yet attainable.

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[*] Substance of an Evening Discourse delivered to the British Association and reprinted by the courtesy of *Nature*.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Import and Export Figures.

The Board of Trade returns of imports and exports for August provide some interesting figures. The imports of forge and foundry pig iron totalled 5350 tons, which was about 1200 tons more than in August last year. The imports of basic iron reached 9000 tons, and it is interesting to note that, whilst the total imports were 14,350 tons, 13,140 tons was provided by British India, and of the remainder 1180 tons came from Sweden. The exports of pig iron were 9093 tons in August, Italy being the largest consumer, with 1952 tons, whilst France took 1363 tons and Germany 1141 tons. For the eight months ended August 31st the total imports of pig iron were 63,649 tons, whilst the exports were 67,533 tons. Considerable interest attaches to the figures relating to imports of semi-finished steel. In August 20,085 tons of blooms, billets, and slabs were imported, compared with 28,464 tons in August, 1932. Of the quantities sent in last month, 10,512 came from Belgium, 5206 tons from France, and 4052 tons from Germany. In August, 1931, before the duties were imposed, the total was 32,905 tons. The total for the first eight months of this year reached the impressive figure of 138,909 tons, but this is relatively small compared with 266,675 tons for the similar period in 1932 and 305,705 tons in 1931. The imports of sheet bars and tin-plate bars last August were 4168 tons, compared with 19,949 tons a year ago. The figures for the period January–August of this year, when compared with previous years, give a good idea of the effect of the duties upon the importation of this class of material. In the eight months ending August 31st, 1931, the imports were 409,804 tons; in 1932 they were 318,677 tons, but this year they dropped to 48,878 tons. In the case of finished steel materials the import figures for a number of descriptions remain fairly steady. For instance, in August 4996 tons of girders, beams, and joists were imported, compared with 4378 tons in August, 1932, whilst for the first eight months of this year the total was 39,540 tons, compared with 35,448 tons for the similar period in 1932. Export trade in iron and steel was fairly satisfactory last month. The movement of galvanised sheets was especially encouraging, the total being 23,985 tons, compared with 20,153 tons in July, the figures of August last year being 19,121 tons. An improvement is also to be noted in the export of plates, which reached 11,601 tons in August, the total for the eight months being 87,222 tons, compared with 77,573 tons for the first eight months of 1932.

The Continental Position.

Although meetings of the European Steel Cartel were held last week, no announcement, either regarding policy or the position of the steel works, has been made. It is known, however, that the situation has deteriorated sufficiently to cause anxiety. In Belgium practically all the works are compelled to close departments at frequent intervals from lack of orders, and the French home demand, which for some time past has been the mainstay of the French steel industry, now shows signs of declining. The Cartel, however, has maintained its gold quotations, and the rate of exchange which existed most of last week and the beginning of this week has enabled it to compete for business in the British home market at figures well under the quotations of the British manufacturers. That they have taken comparatively little business is largely due to the fact that many of the British consumers have running contracts with British works. Another factor in the situation is that the exchange fluctuates so rapidly these days that buyers adopt a cautious policy in dealing with countries upon the gold standard. The movements of the dollar this week have, of course, disturbed all markets, and there has been a certain amount of American competition. Sales of the lighter steel materials have been made to buyers in this country and on the Continent, and it is reported that some American tin-plates have been sold in Germany. On the whole, however, the competition experienced from the United States is not so serious as might have been anticipated. There seems to be, however, a general feeling that if the dollar deteriorates further American rivalry may become a grave menace to other steel-producing countries.

Pig Iron Production.

THE National Federation of Iron and Steel Manufacturers, in the preface to its figures of iron and steel production for August, states that there were seventy-three furnaces in full blast at the end of the month, the four furnaces which had been damped down at the end of July having resumed operations, and two other furnaces which were put into blast being offset by two which ceased production during August. Although it is not stated in the report, of the two furnaces put into commission, one was at the works of Walter Scott, Ltd., Leeds, and one at David Colville and Sons, Ltd., whilst one furnace at the Millom and Askham Hematite Iron Company, Ltd., and another at G. and R. Thomas, Ltd., in the Midlands, ceased production. The output of pig iron in August amounted to 362,700 tons, compared with 343,900 tons in July and 259,400 tons in August, 1932. The production includes 104,300 tons of hematite, 168,700 tons of basic, 74,100 tons of foundry, and 7800 tons of forge pig iron. The output of steel ingots and castings in August was affected by the holidays, and amounted to 551,300 tons, as against 567,500 tons in July and 361,500 tons in August, 1932.

Pig Iron.

Business in pig iron has been on a satisfactory scale for some time and a further expansion is looked for during the present quarter. Active conditions are reported on the North-East Coast, and not only are local consumers taking increased quantities, but overseas business has improved. One of the most encouraging features is that Denmark has taken about 3000 tons. The demand for hematite also has increased, business having been done on a good scale with Sheffield and South Wales consumers. Hopes are entertained that production will be increased shortly. Already one furnace has been started up this month, and it is expected that one or two more will be relighted in the near future. The demand for Cleveland iron from Scotland looks like increasing at the current figures of 65s. 3d. d/d Glasgow and 62s. 3d. d/d Falkirk. In the Midlands also the situation is satisfactory, and business has expanded since the beginning of the month, although many of the large consumers have covered their forward requirements, and the demand at the moment consists chiefly of small parcels to meet current needs. The light castings foundries are the principal buyers and are busily employed, particularly those supplying the building trades. An encouraging feature is the better demand for forge iron, which is quoted at 61s. for Derbyshire brands and 57s. 6d. for Northamptonshire. In Lancashire the demand for pig iron does not seem to be so good, but this is probably because consumers there covered their requirements a short time ago, many of them buying well forward. Specifications against these contracts are coming forward satisfactorily. For the time being the demand is light, but one of the favourable features of the position is the tendency for scrap prices to rise, which should be a factor in improving the demand for pig iron. On the North-West Coast business in hematite has been maintained. Buying has been of a hand-to-mouth character, but the makers have good orders on their books, against which consumers are specifying with fair regularity. The local consumption is good and a considerable amount of iron is going to the Midlands and South Wales. The position of the Scottish producers has not altered much recently. Business in foundry iron is light, but it is expected that the output of basic will be increased shortly.

Semi-finished Steel.

The volume of business in semi-finished steel has become somewhat irregular. In one or two districts little business has been transacted of late, but this is probably due to the fact that many consumers have covered their requirements well into the fourth quarter. From the manufacturers' point of view the position is so satisfactory that many of them have been encouraged to ask prices higher than the official quotations. For instance, billets, which until recently have been booked at £5 for 500-ton lots and £5 7s. 6d. for lots of 100 tons or less, are now difficult to obtain at less than £5 2s. 6d. to £5 5s., unless the tonnage is particularly attractive. In Lancashire, where the demand is distinctly quiet, it is possible that the makers would be more willing to meet consumers, but in the Midlands up to £5 5s. and £5 10s. has been quoted, the higher figure being for small quantities. Similarly, the quotation for sheet bars has advanced, probably as a result of the busier conditions which have developed in the black and galvanised sheet branch of the industry. The price of £4 15s. which has ruled for some time on the North-East Coast, has been advanced by most makers to £4 17s. 6d. to £5, and this position seems to be gradually spreading to other districts in England. In Wales, however, sheet and tin-plate bars are kept at the official figure of £4 15s. d/d. In spite of the advance in prices, Continental competition is seldom met with in the home market. The sales organisations of the Continental works are prepared to discuss terms irrespective of the official prices, which, when the depreciated exchange and the duty are taken into account, are nearly as high as the British quotations. It is only occasionally, however, that Continental works press large offerings on the British market, since they are not attracted by the prices they must accept. British import merchants who are excluded by the Continental works from participating in any business in semi-finished material have adopted a strong attitude, and negotiations have been opened with the Continental makers which may result in the situation being altered.

N.E. Coast, the Midlands, and South Wales.

Conditions in the manufactured steel department have not materially changed over the week, but there is evidence of a steady, if slow, expansion in business. In a few departments there is considerable activity, and some works are booked up for several weeks ahead. The galvanised sheet section of the market, for instance, which until recently was probably more depressed than any other, is now well employed as a result of recent orders, and several makers have temporarily withdrawn from the market. The tin-plate works have been operating at between 65 and 70 per cent. of capacity for several months and constructional engineers, generally speaking, have found business improving of late, although conditions in this industry are irregular. The demand for strip, hoops, and steel bars is a feature of the market, and some of the English re-rollers are working at a high rate. On the North-East Coast the active conditions that have ruled for the past two or three months are well maintained. In this district the constructional engineers are supplying the steel works with a fair amount of work. The rail mills also are well employed. The demand for shipbuilding steel, however, remains poor. In the Midlands general business in finished steel is improving and orders for bars, joists, and sections are reaching the mills more freely than for some time past. The re-rollers are well off for work, but this week there has been a revival of competition from the Continent, chiefly in small steel bars. The Continental quotation has dropped to £6 9s. delivered Birmingham, against the re-rollers' quotation of £6 15s. to £6 17s. 6d., to which it was recently raised. The English steel makers quote £7 to £8. Although some orders have gone to the Continent, they appear to have been confined to small tonnages. Some disappointment is felt in the Midlands that the usual seasonal demand from the collieries for arches, rails, and other material does not materialise. Reports from South Wales indicate that business has been quiet of late, but most of the works have well-filled order books.

Scotland and the North.

One of the most encouraging features in the position of the Scottish steel industry is the busy conditions at the Clydebridge Works of David Colville, Ltd. The three shift system is in operation on the plate mill and for the first time for years the mill has been working night and day. There is only a sluggish demand for structural material and most of the orders received are for small tonnages; but even in this department production is maintained at a higher rate than ruled last year. Business in tubes, also, has increased recently and the Mossend Works of Stewarts and Lloyds, Ltd., are working full time. The Scottish re-rollers do not appear to be so well off for work as their English competitors and in particular are finding export business difficult to secure. Disappointment continues to be felt in Lancashire at the slow development of the demand from the general engineering firms. Earlier in the year a short-lived improvement in the position of this industry encouraged hopes that have not been realised. On the other hand, the constructional engineers appear busier and are taking better deliveries of joists and sections. Business in plates has been confined this week to a few small transactions, and the call for boiler plates does not seem likely to improve as the boilermakers are poorly employed. There is a good business passing in bright-drawn bars and in some of the special steels. In the Sheffield district the volume of business appears to be steadily improving. One authority places the production of steel there at 1000 tons per day higher than at this time last year. The gradual growth of the demand for special steels is an encouraging feature, and a large export order for tool steel has been secured and will be divided between several firms. The wire rod mills have a considerable number of orders on their books and the demand for stainless steel sheets is on a satisfactory scale. Business in hot and cold-rolled strip, which has been active for some time, has, if anything, increased of late. On the North-West Coast the steel works have found new orders scarce, but there is sufficient work in hand to keep them employed for a considerable time.

American and British Capital.

One of the consequences of the American slump and the readjustment which it caused in many businesses on the other side of the Atlantic has been that interests held by American concerns in this country have been disposed of in a number of cases. It is only natural that the tendency should be for firms to concentrate upon the markets with which they are best acquainted, and this often provides a reason for the severance of foreign financial relations. During the past year or so a number of instances have occurred in which American holdings in British companies have been transferred to British interests, and in some cases also a reverse action has taken place. Various reasons are responsible besides those mentioned for this development, but, generally speaking, such considerations have carried weight. A dissolution of British and American interests which is of considerable interest is understood to have just taken place. Negotiations which have been proceeding for some time have now been completed, and the shares held by the International Combustion Engineering Corporation of New York in International Combustion, Ltd., of Aldwych House, Aldwych, London, W.C.2, have been acquired by English interests. No shares are now held in the United States.

Copper and Tin.

The slight burst of activity that occurred in the electrolytic copper market at the end of last week was short-lived, and this week the market seemed to have dropped back into a listless condition. American consumers bought a little more freely and business in Europe, although it has been irregular, has been on a slightly improved scale. There is no doubt that the buying was caused by rumours of American monetary inflation, and it is probable that in the United States a certain amount of copper was bought as an investment. The American domestic price has been held at 9 cents, and apparently there has been little or no selling by second-hands to disturb the market. The sterling quotation has moved between £38 5s. and £38 15s. c.i.f. British consumers have not shown much interest in the market, and the principal export buying has been from Germany, and to some extent from France. Some transactions are reported to have been entered into for delivery up to the first quarter of next year, but the quantities involved were not large. Estimates of the American copper position at the end of August give a reduction of 23,500 tons in the stocks. The stocks in the American producers' hands, however, are still heavy enough to be a burden to the market. Business in the London standard market reflected the activity of electrolytic copper, but this week an easier tone developed. Prices have moved within a narrow margin, and for the time being speculators are showing little interest in this market. . . . The American situation also influenced the tin market, but expectations that American buying would revive on a considerable scale as a result of the threat of inflation have not been realised. A certain amount of buying took place at the end of last week, but not enough to influence prices seriously, whilst the Continent has shown little interest in the market. The statistical position of the metal continues to improve, and last week there was a very heavy reduction in the stocks of the United Kingdom owing to large shipments of tin to the United States. The International Tin Pool met this week, but although it had been suggested that the production quota would be increased, no announcement followed the meeting. This has confirmed the belief of the market that no change will be made until January. The uncertainty, however, on this point has no doubt done something to check speculation in the metal.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers : joists, 22s. 6d. ; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	2 19 0	2 19 0
No. 1	2 19 6	2 19 6
Cleveland— *(D/d Tees-side Area.)*		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
MIDLANDS—		
Staffs.— *(Delivered to Black Country Station.)*		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—

N.W. COAST—

Hematite Mixed Nos.	3 15 6	d/d Glasgow
	4 0 6	„ Sheffield
	4 5 6	„ Birmingham

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d.	10 0 0	9 0 0
21-G. to 24-G., d/d.	10 5 0	9 5 0
25-G. to 27-G., d/d.	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over ; 2-ton to 4-ton lots, 10s. per ton extra ; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export ; £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/9 to 17/-
Tin-plate bars, d/d South Wales works, £4 15s.

Billets.	£ s. d.
Basic Soft (25·41% C.)	5 15 0
„ Medium (0·42% to 0·60% C.)	6 12 6
„ Hard (0·61% to 0·85% C.)	7 2 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 25% C.), 500 tons and up	5 2 6
100 tons	5 10 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/- per lb.	
Ferro Tungsten	1/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 17 6	7/-
„ „ 6 p.c. to 8 p.c.	£19 17 6	7/-
„ „ 8 p.c. to 10 p.c.	£18 17 6	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£30 0 0	9/-
„ „ „ 1 p.c. carbon	£31 0 0	10/-
„ „ „ 0·70 p.c. carbon	£35 2 6	12/6
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 5 0 home	
„ Silicon 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£18 12 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, September 20th.

COPPER—		
Cash	£34 11 3 to £34 13 9	
Three months	£34 15 0 to £34 16 3	
Electrolytic	£37 5 0 to £38 5 0	
Best Selected Ingots, d/d Birmingham	£38 5 0	
Sheets, Hot Rolled	£66 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9¼d.	9¼d.
„ Brazed	11¼d.	11¼d.
TIN—		
Cash	£216 10 0 to £216 12 6	
Three months	£216 10 6 to £216 12 6	
LEAD :	£11 16 3 to £11 12 6	
SPELTER :	£16 16 3 to £17 0 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 14/-
„ Glasgow— Ell	13/6 to 13/9
„ „ Splint	14/6 to 14/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	11/3 to 11/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/3 to 12/6
Unscreened Navigation	12/- to 12/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	11/- to 11/6
Secondary Steam	10/6 to 10/9

ENGLAND.

YORKSHIRE—		
Steams		15/6 to 18/-
Furnace Coke		11/- to 12/-
NORTHUMBERLAND—		
Best Steams		13/6 to 14/6
Second Steams		12/6 to 13/-
Steam Smalls		8/6
Unscreened		11/6 to 12/6
DURHAM—		
Best Gas		14/6
Foundry Coke		16/6 to 17/6
SHEFFIELD—	Inland.	
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	22/- to 24/-	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	8/- to 9/-	—
Nutty Slacks	7/- to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Admiralty Large	19/6
Second Smokeless Large	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	18/3 to 18/6
Best Steam Smalls	13/6 to 14/-
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 26/-
Foundry Coke	19/- to 36/-
Furnace Coke	15/- to 17/6
Patent Fuel	21/-
SWANSEA—	
Anthracite Coals :	
Best Large	35/- to 38/6
Machine-made Cobbles	35/- to 48/6
Nuts	37/6 to 48/6
Beans	25/- to 30/-
Peas	18/- to 20/6
Breaker Duff Rubbly Culm	10/- to 11/-
Steam Coals :	
Large	18/- to 20/6
Nuts	18/- to 25/-
Smalls	11/- to 13/-

FUEL OIL.

Inland consumption ; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	3¾d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Foreign Exchanges and Quotas.

As stated in a previous note the Government has decided to suppress three-quarters of the import quotas based upon the percentages of particular goods received from each country during a specified period, and to make use of those quotas as a means of exchange during negotiations for new treaty arrangements. A first list of goods to be freed from quotas has just been published. For the moment, the only engineering productions released from the quota system are traction engines and road rollers, steam boilers and transmission systems, while cutlery and steel furniture are also included in the list. At the same time, the Cabinet has met to discuss the policy to be adopted in order to facilitate foreign trade. This matter has become extremely urgent in view of the rapid decline of exchanges, particularly the exports of manufactured goods, and the reorganisation of the foreign trade is to be carried on simultaneously with reforms that must be undertaken to avoid serious risk to the country's financial stability. One of these reforms cannot be accomplished successfully without the other. Negotiations have long been in progress with several countries, and have been held up because there has been no means of settling upon an acceptable system of exchanges, but with the partial removal of the *pro rata* system the Government believes that it has now the means of offering advantages which will allow of negotiations being carried through satisfactorily. The first step has been to apply a quota to imports of dairy produce from the Irish Free State in return for certain French products. Another reason for an urgent solution of the difficulties that stand in the way of foreign exchanges lies in the arrangements being made between other countries which may have the effect of excluding French interests altogether, such as the agreement between Germany and Rumania, whereby the latter country undertakes to purchase German goods in return for an equivalent value in cereals. This releasing of quotas for the purpose of exchange may also allow of negotiations being resumed with Great Britain. They were initiated by French Ministers in London during the World Economic Conference. On their return it was announced that the Government contemplated the suppression of the compensating duty on British goods; but in view of protests from industrial interests the suggestion has apparently been allowed to drop. The compensating tax has not been imposed on goods from the United States, despite the fact that the dollar has depreciated to the same extent as sterling.

The Port of Dunkirk.

The changed economic conditions in the North of France after the war, when the reconstruction practically doubled the industrial capacity and the retrocession of Alsace-Loraine brought a new volume of traffic within the French transport system, induced the Dunkirk Chamber of Commerce to carry out works for an extension and equipment of the port in order to divert to it the traffic that was being sent by way of the Rhine and other waterways to Rotterdam and Antwerp. It was also believed that Dunkirk would become a convenient port of transit for cereals to Central Europe, for which purpose a vast grain elevator has been constructed. The success of the scheme depends upon an improvement of the canal system across the North of France, and this is being accomplished by deepening and widening the canals and creating an inland port at Lille. The programme of works at Dunkirk is being continued by the construction of an outer port which will have an area of 200 acres. It is enclosed by two piers converging to a point and providing an opening of 270 m. The eastern pier is an extension of an existing jetty and is built up with reinforced concrete piles on concrete foundations 17 m. by 7 m. The piles have a height of 7 m. and are placed 3·5 m. apart. They are precast, and are placed in position with a portal crane on a temporary metallic staging. The western pier serves as a breakwater, and is made of concrete blocks weighing 50 tons laid on a rock foundation. The outer port is being put into communication with the canals by means of a lock 280 m. long and 40 m. wide. The terminals of the canals themselves have also necessitated a considerable amount of work.

An African Tunnel.

The driving of the tunnel 1609 m. long through the Bamba mountain for the Congo-Ocean railway was completed last week, when the galleries from each end joined with a difference in level of less than 4in. All the work on the line between Brazzaville and Pointe-Noire has been extremely arduous, partly over marshes and through jungles where malaria exacted a heavy toll on labour, and the difficulties were no less serious during the construction of the tunnel which had to be driven with great caution. Water and mud constantly invaded the workings. The Bamba tunnel removes the last obstacle to the construction of the line, and work can now be continued normally with a prospect of the railway being put into service in March next. For several months past it has been used for transport by transferring passengers from one completed section to the other by means of motor cars. Unfortunately, the engineer in charge, Monsieur Girard, of the Société de Construction des Batignolles, lost his life in an accident on the line. Nearly the whole of his career had been devoted to colonial railway construction.

The Bargemen's Strike.

The recent bargemen's strike terminated on the Minister of Public Works promising to put into effect certain changes in the regulations governing traffic on the canals, notably the suppression of priority to motor boats passing through locks, the object of this measure being to deprive motor barges of any preference over electrically hauled boats. The strike was resumed last week on the ground that the new rule was not being observed, and that permits to barges carrying perishable goods were given to others not entitled to them. This uncompromising attitude of the bargemen is making it more than ever difficult to conciliate the interests of electrical haulage and oil-engine traction.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

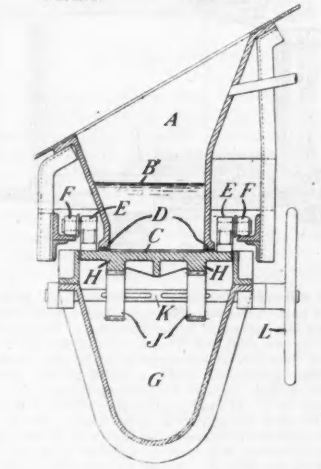
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

396,767. February 5th, 1932.—REMOVAL OF ASH FROM FURNACES, The Underfeed Stoker Company, Ltd., of Aldwych House, Aldwych, London, W.C.2, and Howard Kerr, of 37, Oak-avenue, Shirley, Surrey.

According to this invention a hopper or receptacle, placed at the rear of a boiler stoker, is adapted to contain water and is provided with a displaceable bottom normally making water-tight connection with the hopper walls, whereby its contents may be discharged into a sluicing channel or other conveying device. The ash being more or less quenched on falling into this water-filled hopper has no adhesive tendency, so that clinker is not formed. Provision may be made for automatically or otherwise making good any water evaporated from the hopper by the heat of the ash. A is a hopper the mouth of which is situated beyond and below the rear end of the stoker, which may be of any suitable type. The ash from the stoker falls either directly or through a chute into the hopper A containing water. When the hopper A contains no ash, the water stands at a level B, so that when the hopper is filled with ash it will rise to the top of the hopper, or to an overflow lip or discharge aperture leading to a sump or other receptacle. The hopper A has a movable closure or bottom C between which and the walls of the hopper a water-tight or approximately water-tight joint is maintained by sealing strips or gaskets D accommodated in grooves. The bottom C of the hopper is bolted to brackets E, in which the axles of bearing rollers F are journalled. Below the hopper A is a sluicing channel G or other receptacle into which the contents of the hopper are discharged for removal by any suitable means when the bottom C of the hopper is displaced laterally with respect to the body portion of the hopper. This movement of the bottom may be effected by means of a rack or racks H actuated by pinions J keyed on a transverse shaft K journalled in the framework and rotatable in its bearings as by means of a hand wheel L.—*August 8th*, 1933.

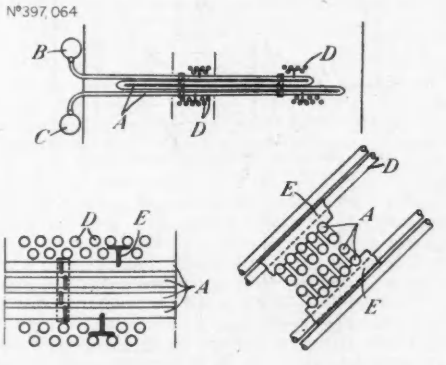
N°396,767



397,064. March 30th, 1933.—SUPERHEATER ELEMENTS IN WATER TUBE BOILERS, *The Superheater Company, Ltd., of Bush House, Aldwych, London, W.C.2.*

The object of this present invention is to provide a simple and efficient means for positioning and supporting the superheater elements in a water tube boiler. A indicates a superheater element comprising four branches or pipe lengths arranged side by side in a common plane, and B and C indicate the saturated steam and superheater steam headers respectively. The elements of the superheater are arranged in a space between rows or banks of water tubes D. Secured to water tubes at opposite sides of the space in which the superheater elements are accommodated are supporting members E, which are formed of lengths of "T" iron, the flanges of the "T" iron being welded to two of the water tubes, the web having spaced semi-circular notches or recesses to receive the outer legs or branches of the superheater elements. In the example shown, the recessed members E are welded to water tubes in the row next to the row adjacent to the superheater elements, the flanges of the "T" iron being welded to the sides of the water tubes facing the superheater elements.—*August 17th*, 1933.

N°397,064

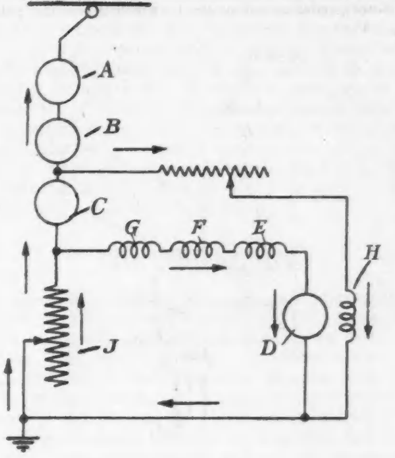


DYNAMOS AND MOTORS.

396,410. February 2nd, 1932.—CONTROL OF DIRECT-CURRENT ELECTRIC MOTORS, Frank Whyman, of "Arncott," Greenway-road, Timperley, Chester; and Associated Electrical Industries, Ltd., of Crown House, Aldwych, W.C.2.

In systems of electric motor control wherein provision is made for electric propelling motors to work regeneratively it has been proposed to utilise one of the propelling motors when working regeneratively to supply excitation current for the other motors, and the present invention provides new arrangements of this kind. The armatures of the four motors are indicated at A, B, C, D and their respective field windings at E, F, G, H. The connections shown are when the motors A, B C are regenerating for the purpose of returning current to the line. The armatures of these motors are connected in series with a stabilising resistance J between the supply conductor and earth. The field windings E, F, G of the three motors are connected in series with the armature D of the fourth or exciting motor across the stabilising resistance J. Two alternative methods of carrying out the invention are described.—*August 2nd*, 1933.

N°396,410

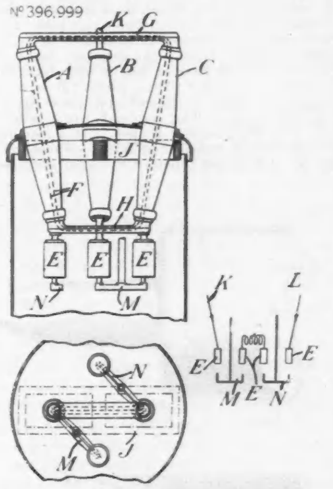


SWITCHGEAR.

396,999. December 16th, 1932.—LIQUID BREAK ELECTRIC CIRCUIT BREAKERS, *International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.*

On the cover of the series-multiple break liquid circuit breaker, described in this specification, there are four bushings, of which only three, A, B, C, are shown, which carry the explosion chambers E. The bushings and explosion chambers are arranged symmetrically in a circle. Through the two diametrically opposite bushings A and C, the high-voltage-winding F of a current transformer is wound in several layers. Outside of the bushings it is conveyed in strong tubes G, H, which brace the ends of the bushings A and C. The two transformer bushings also pass through the windows of the core J, which carries the secondary winding of the transformer. Instead of a single core, a separate core can be provided for each of the bushings A and C. The bushing B and that diametrically opposite to it carry the conductor connections K, L. The two movable switch cross-bars M and N bridge adjacent explosion chamber contacts in the manner shown.—*August 17th*, 1933.

N°396,999

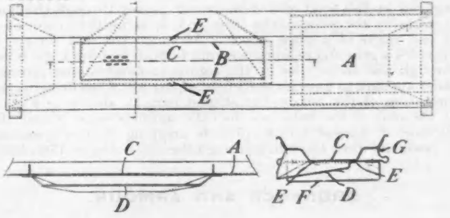


CRANES AND CONVEYORS.

396,602. December 10th, 1932.—CONVEYORS, The Fife Coal Company, Ltd., and John Paton, both of Leven, Fifeshire.

This invention is concerned with conveyors with a connected series of pans and although applicable to conveyors of the scraper type, is specially applicable to those of the jigging type. The conveyor shown includes a base A with a gap B accommodating a perforated plate C which serves as a screen. On the underside of the pan adjacent to the perforated plate C is a reversible chute D, which serves to convey coal dust, &c., to one side of the conveyor after passing through the perforated plate C. The chute D is secured to the tray by bolts, and when it is desired to reverse the chute it is removed from the tray and after it has been turned through 180 deg. it is again secured to the tray. The plate is joggled along its lateral edges so as to form flanges E adapted to be bolted to the base of the pan. F denotes a pair

N°396,602



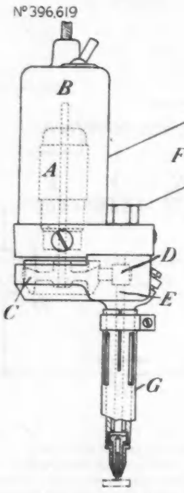
of flats bolted to the lugs G to shield the chute from contact with fixed objects below the pan.—*August 10th*, 1933.

MACHINE TOOLS AND SHOP APPLIANCES.

396,619. January 11th, 1933.—Portable Electric Grinding Machines, Robert Bosch Aktiengesellschaft, of 4, Militärstrasse, Stuttgart, Germany.

An electric motor A is arranged in the casing B. The shaft of the motor carries a belt pulley C, which drives the pulley D connected to the driving spindle E. The outstanding feature, however, is that in addition to the handle F an insulating sleeve is provided at G, and when exceptionally small objects have to be ground or when very exact grinding has to be done the tool is held by this sleeve instead of the handle F.—*August 10th*, 1933.

N°396,619



396,841. March 1st, 1932.—Mandrels for use in Making Metal Tubes, James Robert Garner, of Sheffield Tube Works, Alsing-road, Wincobank, Sheffield.

The mandrel described in this specification is for use in making metal tubes by the cupping or push bench process, in which a partially pierced heated billet is placed on the end of the mandrel and forced through a die, or, in the case of smaller tubes, through a succession of co-axially disposed dies. The object of the invention is to provide means for shaping the leading end of the tube during the push bench process in such manner that when the mandrel is withdrawn from the tube the latter is ready, with little or no further preparation, to be cold drawn into a smaller diameter tube. The mandrel comprises a cylindrical portion A of the desired length and diameter. At its operative end it is provided with a piercer B surrounded by a gripping region C, which operates to push and draw the billet through the die or dies. The piercer B projects from the flat end surface C of the mandrel proper, and a rounded edge or corner D is provided between the flat end surface and the cylindrical part A. A rounded junction E is also provided between the piercer B and the end surface C. The piercer is provided by a pointed stem which may be integral with the mandrel, or may be screwed, welded, or otherwise secured to it. Experiments have shown that a mandrel with the stem of its pointed piercer having a diameter approximately one-third that of the mandrel, may be successfully used in a push bench process of tube forming. The billet is pierced at the first die and it is found that the leading end of the tube F is cup-shaped, as shown in Fig. 2, when the mandrel is withdrawn, so that it may be engaged by the head of a stem or bolt passed through the hole G made by the piercer, the stem or bolt being then connected to the chain of a draw bench. Although the end surface C provides a gripping region operating to push and draw the billet through the die or dies at the commencement of the process, there appears to be a forward flow of the metal resulting in the formation of the hollow cup-shaped part H, shown in Fig. 2, at the end of the tube, so that the annular edge D and the shoulder E appear also to provide gripping regions operating to push and draw the billet through the die.—*August 17th*, 1933.

N°396.841

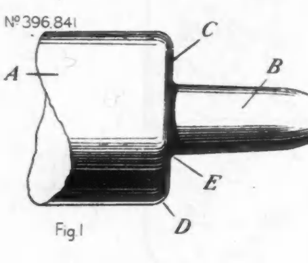


Fig. 1

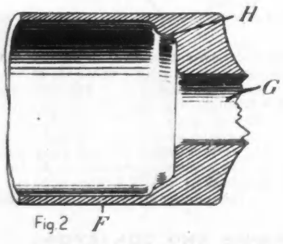


Fig. 2

ORDNANCE AND ARMOUR.

396,405. February 2nd, 1932.—Relatively Bullet-proof Sheet Materials or Moulded Compositions, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

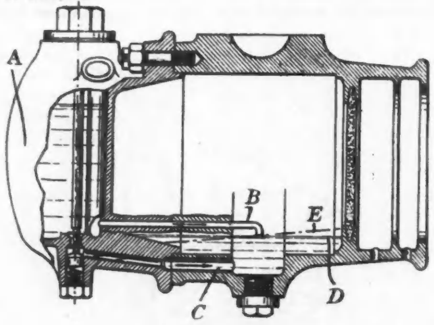
According to this invention, a moulded laminated bullet-proof material is formed of alternate sheet layers of fibrous material and of an abrasive such as finely powdered glass, quartz, sharp quality sand, or carborundum, the layers being bonded together with a resinous composition or a varnish which hardens under subsequent heat and pressure treatment. In carrying the invention into effect according to one form sheets of glass paper are impregnated with a synthetic resin, for example, of the phenolic-aldehyde type, or with a varnish containing synthetic resin, or one containing such bonding media as bitumen or albumen, the sheets being subjected to heat and pressure to cause bonding. The number of sheets bonded together depends on the required thickness of the finished board. It has been found that a comparatively thin board of material made in this way will effectively arrest a rifle or machine gun bullet.—*August 2nd*, 1933.

MISCELLANEOUS.

396,413. November 27th, 1931.—Boxes of Axle Bearings, Jules Edmond Joseph Leroy and Auguste Louis Marie Antoine Rouy, both of 17, Rue de la Bienfaisance, Paris, France.

The type of bearing to which this invention applies usually consists of two sets of needle bearings and also a thrust bearing preferably mounted between the two needle bearings, but the illustration does not show the bearings or shaft. The reservoir A is connected to the oil bath by two conduits B C, one of which starts at the base of the reservoir and ends below the surface of the oil in the bath, and the other starts at the top of the reservoir and ends substantially at the surface level of the oil in the oil bath, and at the line of intersection of the planes, which the surface level of the oil may assume for various lateral inclinations of the journal box. When the level of the oil in the chamber is lowered, air will enter through the conduit B and thus proceed to the upper part of the receptacle A. At the same time the oil flows through the passage C in the direction of the arrow. Thus the level of the oil rises and the oil soon closes the end of the passage B so that the air will cease to enter the upper part of the receptacle. Under the action of atmospheric pressure the oil will cease to flow through the passage C and the level will become steady at D. When the journal is exactly horizontal the surface of the oil in the axle-box is at D, but when the journal becomes inclined as occasioned, for instance, by an inclination of the track on curves, the surface of the oil bath will have the level shown by the line E. It will be observed that this line intersects the level line D and no air will enter and hence there will be no improper reduction in the supply of oil when the journal is inclined.—*July 29th*, 1933.

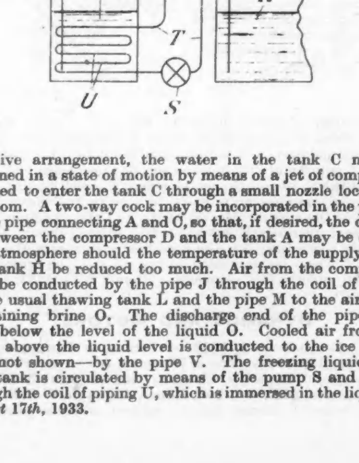
N°396,413



396,912. June 13th, 1932.—The Manufacture of Ice, Hugh Archibald John Macpherson, of 100, Logan-street, Glasgow.

According to this invention ice-making plant includes means whereby air from the ice tank, after being used for agitating the water in the mould boxes, is used as a cooling medium for the water to be frozen, and is then conducted back to the compressor for supplying the agitating air. Air from the ice tank A is conducted by a pipe to a tank C, and from this tank to the suction side of the air compressor D by a pipe E. The tank C is provided with a coil or coils of piping F connected to a water supply G, which may include a filter, and to the tank H from which the mould boxes are supplied. Alternatively, the coil or coils of piping F may be connected to the suction side of the compressor, and to the ice tank, and the tank C may be connected to the water supply and to the supply tank H, whereby the air flows through the coil or coils of piping F and the water to be frozen flows through the tank C. In connection with the alternative arrangement, the water in the tank C may be maintained in a state of motion by means of a jet of compressed air caused to enter the tank C through a small nozzle located in the bottom. A two-way cock may be incorporated in the pipe E, or in the pipe connecting A and C, so that, if desired, the connection between the compressor D and the tank A may be opened to the atmosphere should the temperature of the supply water to the tank H be reduced too much. Air from the compressor D may be conducted by the pipe J through the coil of piping K in the usual thawing tank L and the pipe M to the air cooler N containing brine O. The discharge end of the pipe M is located below the level of the liquid O. Cooled air from the space P above the liquid level is conducted to the ice mould boxes—not shown—by the pipe V. The freezing liquid R in the ice tank is circulated by means of the pump S and piping T through the coil of piping U, which is immersed in the liquid O.—*August 17th*, 1933.

N°396,912



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day and Saturday, September 23rd.

Shipping, Engineering and Machinery Exhibition.—Olympia, London, W. Daily, 11 a.m. to 9 p.m.

Wednesday, September 27th.

Electrodepositors' Technical Society.—Lyons' Angel Café, Islington, N.1. Discussion, "The Removal of Electrodeposits by Stripping." Openers, Messrs. F. L. James and J. W. Perring. 7.30 p.m.

Institution of Welding Engineers: North-Western Branch.—Manchester College of Technology, Manchester. "Experiences by Practical Welders." Speakers, Messrs. W. Bellingham, W. W. Ely, C. Peat, and E. W. Hart. 7.30 p.m.

Thursday, September 28th.

Inst. of Locomotive Engineers.—At Inst. of Civil Engineers, Gt. George-street, S.W.1. Presidential Address, "Colonial Railways," Major Charles Williams, C.B.E. 6 p.m.

Saturday, September 30th.

Manchester Assoc. of Engineers.—Visit to works of Henry Simon, Ltd., Cheadle Heath. 2.15 p.m.

Tuesday, October 3rd.

Inst. of Engineers and Shipbuilders in Scotland.—Elmbank-crescent, Glasgow. Presidential Address, Professor J. D. Cormack.

Wednesday to Saturday, October 4th to October 14th.

Institute of Patentees.—Central Hall, Westminster, S.W.1. Ninth International Exhibition of Inventions. Daily.

Thursday, October 5th.

Stephenson Locomotive Society.—No. 1, Dining Club, King's Cross Station, N.1. "The Railways of South Wales," Mr. D. S. Barrie. 6.30 p.m.

Friday, October 6th.

Inst. of Chemical Engineers.—In Rooms of Chemical Soc., Burlington House, W.1. "The Sedimentation of Fine Particles in Liquids: A Survey of Theory and Practice," Mr. R. F. Stewart and Dr. E. J. Roberts. 6 p.m.

Institution of Sanitary Engineers.—Caxton House (Hill's Restaurant), Tothill-street, Westminster, S.W.1. Opening sessional meeting. Reception, 7.30 p.m.; music and dancing, 8 p.m. until 11.30 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Education with Particular Reference to the Engineer," Mr. K. W. Willans. 7.30 p.m.

Physical Society.—At Royal Institution, 21, Albemarle-street, W.1. Council meeting, 4 p.m.; extraordinary general meeting, 5.30 p.m. Thomas Young Oration, "Thomas Young and the Simplification of the Artist's Palette," Dr. Herbert E. Ives. 5.45 p.m.

Railway Club.—57, Fetter-lane, E.C.4. "Permanent Way," Mr. W. A. Willox. 7.30 p.m.

Thursday, October 12th.

Diesel Engine Users Assoc.—Joint meeting with Inst. of Chemical Engineers, Caxton Hall, S.W.1. "Treatment of Cooling Water for Diesel Engines," Mr. L. O. Newton. 3 p.m.

Royal Aeronautical Society.—At Royal Society of Arts, John-street, Adelphi, W.C.2. "Air Traffic Control," Major R. H. S. Mealing. 6.30 p.m.

Friday, October 13th.

Inst. of Engineers and Shipbuilders in Scotland.—Grosvenor Restaurant, Glasgow. "James Watt" dinner.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "The Influence of Harmonics in Transformer Circuits," Mr. E. Ambrose. 7.30 p.m.

Friday, October 20th.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. Annual general meeting. Address by the President, Mr. R. J. Walker; cinematograph film, "Mechanism of Ships' Wake," Professor T. B. Abell.

Saturday, October 28th.

Stephenson Locomotive Society.—Visit to Stratford, L.N.E. Railway Running Sheds. 2.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The British Electrical and Allied Industries Research Association is removing to 15, Savoy-street, London, W.C.2., on September 28th. Telephone numbers will be Temple Bar 7907, 7908, and 7909.

Mr. A. S. Herbert, M.I.E.E., deputy export manager of the English Electric Company, Ltd., and for many years its general manager in Australia, has resigned his position from September 30th in order to join the firm of Herbert and Sons, Ltd., of 6 and 7, West Smithfield, E.C.1, with a seat on the board.

David Brown and Sons (Hudd.), Ltd., Huddersfield, inform us that their subsidiary company, the Keighley Gear Company, has found it necessary to move to larger premises. From September 18th, therefore, the entire plant and *personnel* will be transferred to Prospect Works, Lockwood, Huddersfield.

CONTRACTS.

Ferranti Ltd. have just received an order in the face of world-wide competition for the first large British-made transformer to be installed in Finland. It will be a three-phase unit of 12,000 kVA capacity for operation at 47,000 volts, with on-load tap-changing gear, and it will be used in connection with the transmission of power from the Imatra hydro-electric scheme to the Warkhaus paper pulp factories.

William Asquith, Ltd., Halifax, have received an order for a 48in. carriage and wagon wheel turning lathe for one of the leading Indian Railway Works, and another order from an Indian railway company is for an electrically driven S.C. 1 type radial drilling machine, whilst a locomotive wheel tire drilling and tapping machine is in hand for an Irish railway. Large electrically driven radial drills have also been ordered by a leading home railway company and by the Admiralty, whilst an important omnibus company has placed an order for a crank case boring machine.

A Seven-Day Journal

The Bogie Locomotive.

About this time in September, 1833, the bogie locomotive made its appearance on a British railway, although it was probably preceded by engines built earlier in the same year by Tayleur and Co.—now the Vulcan Foundry, Newton-le-Willows—and R. Stephenson and Co. Two engines were completed in March and April by Tayleur and exported to the Camden and Woodbury Railroad. They would now be described as 4–2–0's. The inside driving axle was under the footplate and the wheels were 4ft. 6in. in diameter. A similar engine was built by Stephensons for the Saratoga and Schenectady Railroad. The bogies were in front. The first British bogie locomotive was constructed by J. and C. Carmichael, of Dundee, for the Dundee and Newtyle Railway, now L.M.S., then on the 4ft. 6in. gauge. It, and its two sisters, had vertical cylinders, 11in. by 18in., placed on the running board just behind the single 5ft. drivers. The motion from the upwardly extending piston-rods was taken by return connecting-rods to large bell-crank levers, the vertical leg of which drove outside cranks by means of connecting-rods. The four-wheeled bogie was at the rear; its wheels were 3ft. in diameter. The boiler pressure was 50 lb. per square inch, the total weight in working order about 9½ tons, and the price £700 each. It is interesting to compare the tractive effort of 1530 lb. at 85 per cent. of the boiler pressure with the 40,300 lb. tractive effort of the "Princess Royal," the latest L.M.S. engine. One of these engines, the "Earl of Airlie," was at work as late as 1850, when it was converted into a pumping engine. Our knowledge of its appearance is due to Alexander Allan, who had it put in order and photographed. A woodcut from the photograph was given in The Engineer of March 2nd, 1883.

Zuider Zee Reclamation.

Last Monday, September 25th, marked the official inauguration of the great dyke across the Zuider Zee from North Holland to Friesland, which is now fully opened for traffic. The inaugural address was delivered by Dr. J. A. Kalff, the Minister for Public Works, and Dr. V. J. P. De Blocq van Kuffeler, Director-General of the Zuider Zee Works, also spoke. On behalf of the contractors a tower built at De Vlieter, the point of closure of the dam, about 90ft. in height, with an observation platform, giving a fine view of the surrounding country, was presented to the Dutch Government. A general description of the Zuider Zee works was given in our issues of August 9th and 16th, 1929, in which reference was made to the entire scheme of reclamation The north-western or Wieringermeerpolder is already under cultivation, and although work on the other sections has been retarded, in view of financial considerations, it has been decided to continue the drainage of the north-eastern polder near to Friesland as soon as the financial situation makes this work practically possible. The Dutch Government has also asked the Netherlands Parliament to vote the first instalment of a credit for the construction of a railway across the dyke, which is designed for a road, a bicycle track, and a double railway track.

An Oil-Electric Tug.

The oil-electric tug "Lectro," which was launched from the yard of Henry Robb, Ltd., of Leith, on Thursday, September 21st, and named by the Marchioness of Linlithgow, has been specially designed for the Thames service of the Union Lighterage Company, Ltd., and will be one of the most powerful vessels operating on the river. The propelling machinery will comprise two 360 B.H.P. Mirrlees oil engines driving B.T.H. generators, supplying current to a 580 B.H.P. propelling motor. Smaller generators will provide current for the electric steering gear, lighting, and other auxiliary services, the whole of the electrical equipment of which is being supplied by the British Thomson-Houston Company, Ltd., of Rugby. The control gear will be directly operated from the bridge, dual bridge telegraphs being employed to control directly the propelling equipment. It is fully anticipated that experience with this new type of vessel under actual river conditions will show an economy in running costs, and will set up a new standard in quick manœuvring capabilities. The tug is expected to be commissioned in a few weeks' time, and special demonstration trials on the Thames are being arranged.

Avon Bridges.

With the placing of a contract for the strengthening of a bridge between Kelston and Weston, the L.M.S. Railway Company has taken the first step in an important scheme of bridge reconstruction on the line between Mangotsfield (near Bristol) and Bath. Under this scheme six bridges carrying the railway over the river Avon on this section of line, together with several smaller bridges on the same route, are to be reconstructed with the object of permitting the use of heavier locomotives than those at present allowed over the line. The Mangotsfield-Bath line of the L.M.S. crosses the river Avon in six places, and in each case the lines are carried over the river by a bridge with two openings. The spans of these openings vary from 75ft. to 106ft. and the central piers in the river consist of cast iron columns supported on screw piles. The main girders are wrought iron of the lattice type, and in four cases there are also wrought iron cross girders, while the other two bridges are of the "deck" type, with the rails directly over the main girders. There are many difficulties to be overcome in the reconstruction of the river bridges, as the traffic on the railway has to be maintained while operations are in progress and at the same time suitable arrangements are necessary for the passage of river traffic. Provision has also to be made in case of floods for the flow of the river to be impeded as little as possible. The superstructures of five of the river bridges are to be entirely reconstructed with new steel main girders and floors of steel and concrete, but in the case of the river bridge near Bath L.M.S. station it is intended to bring the existing main and cross girders up to the required strength. New concrete centre piers are to replace the existing cast iron columns in all six bridges.

Traffic Signals.

Official approval by the Ministry of Transport for the installation of the vehicle-actuated rather than the fixed time type of traffic signal is expressed in a letter recently sent to the Highways Committee of the St. Pancras Borough Council. Reasons for the views held by the Ministry are given in the letter. "This type is more efficient in that it imposes fewer unnecessary delays upon traffic; at the slacker hours of the day this is an important point, since, if vehicles are held up unnecessarily in their path while no traffic is passing in the cross direction, drivers are apt to ignore the signals and proceed on their journey, thus contributing to a disrespect for traffic signals generally." Several important junctions in the St. Pancras area are therefore to be equipped with vehicle-actuated signals. That the views of the Ministry are in agreement with that of many other local authorities is demonstrated by work going on in other parts of the country. Leeds Corporation has, for example, decided to replace existing "time" signals by the "electromatic" type, Edinburgh is experimenting with vehicle-actuated signals, and Birkenhead has just joined the number of towns and cities having the latest type. An interesting reaction also appears to be taking place largely as a result of the development of the "electromatic" signal. At least one of the motoring organisations is urging that such lights should be installed at crossings on big arterial roads instead of the big expensive and complicated islands now common in the London district.

Blowing Up a Viaduct.

A bridge-demolition operation of more than usual interest was carried out at Shottle, some 8 miles from Derby, on Sunday, September 24th, when Royal Engineers from Catterick Camp and Territorial Engineers blew up a nineteen-arch viaduct forming an accommodation bridge across the L.M.S. branch line from Duffield to Wirksworth. The bridge, which was built nearly seventy years ago at a cost of £100,000, had to be constructed in order to obtain wayleave for the building of the railway line which passed through a single arch. It was built by the old Midland Railway Company, and was little used, and in recent years it had to be condemned as dilapidated and unsafe. The Royal Engineers accepted the invitation of the L.M.S. Railway Company to destroy the bridge, and after suitable preparations, including the protection of the track by ballast, operations were begun at 7.30 a.m. on Sunday last. An interesting feature of the work, which extended from the first explosion at 7.30 until the afternoon, was the use of different kinds of charges arranged in different ways. Thus, one group of three arches remained unmoved at the first explosion, a similar group crumbled to the ground, while a third was blown to pieces. It is understood that the Royal Engineers were quite satisfied with the information which was obtained from this practical experience of full-scale bridge demolition.

The Late Dr. Herbert Lapworth.

Civil engineers and geologists alike will learn with regret of the death of Dr. Herbert Lapworth, which took place recently at his home at Sutton at the age of fifty-eight. Herbert Lapworth received his education at King Edward VI. School, at Birmingham, and at the University of Birmingham, and was a pupil of the late James Mansergh, with whom he was engaged on the Elan Valley water supply scheme. During this period he carried out the field work, which he later embodied in an important paper on "The Silurian Sequence of Rhayader," published by the Geological Society of London. After spending some years as resident engineer to various water supply schemes, Dr. Lapworth came to London in 1910, and soon came to be recognised as an outstanding authority on geology as applied to civil engineering. His 1907–8 lectures to the students of the Institution of Civil Engineers on "The Principles of Engineering Geology," will be remembered as models of lucidity and for the knowledge they embodied. Dr. Lapworth was called upon to report upon design and supervise many water supply undertakings, and he also served on several technical committees. He was a member of the Institution of Civil Engineers, a Past-president of the Institution of Water Engineers, a member of the Association of Consulting Engineers, and a Past-secretary of the Geological Society. He had a charm of character which endeared him to a wide circle of friends, who will keenly feel his loss.

The Gas Industry.

In his presidential address, delivered at the annual conference of the British Commercial Gas Association at Bournemouth on Tuesday, September 26th, Mr. William Cash referred to the future of the British gas industry and the necessity of bringing before the public its claim for support, alongside the competitive appeals of the oil and the electrical industries. The sum of two hundred millions sterling was, he stated, invested in the gas industry, and 115,000 people were directly engaged in carrying on the business of the supply of gas to 10,000,000 consumers. Incidentally the industry provided every year large sums of money to pay for coal, constructional works, and the appliances which consumers required, and all that went to provide employment, while as an exporter of various products the industry undoubtedly assisted the export trade of the United Kingdom. The technical efficiency of the gas industries and the sale of by-products had tended to keep the price of gas at a reasonable figure. Referring to the future of the gas industry, and the manufacture of motor spirit as a by-product, Mr. Cash said that there were about 400 gas undertakings, each carbonising 20,000 tons of coal or more a year, but less than 100 of them were making motor spirit. There seemed to him to be in that direction an opening for a very substantial development of a national product.

The New Holborn (Kingsway) Station.

Early on Monday morning last, September 25th, the new Holborn (Kingsway) Station was completed and opened for public service. It now serves both the Piccadilly line and the Central London Railway and is provided with seven fast escalators. Four of these are claimed to be the longest now in use. They work on one shaft and each has a length of 157ft. 7in. The working speed is variable, according to the traffic demands, but at rush hours they can be run at a maximum travelling speed of 160ft. per minute. The new Central London Railway station has been constructed 250 yards east of the old British Museum Station, which is now closed, and over a year and a-half has been spent in constructing a tunnel from the new Holborn (Kingsway) Station to the new Central London Railway station platforms. During the whole of the time the work was carried on without interrupting the train service. The new C.L.R. station is complete with a signal cabin embodying the latest equipment, and a new booking office of the passimeter type has been erected at the Holborn Station. The work has cost approximately half a million pounds, and is expected to bring a material increase in the amount of traffic handled.

Business Efficiency.

At the opening of the Business Efficiency Exhibition at the White City on Tuesday last, Lord Melchett referred to the progress made in the mechanisation of office equipment and commented on the fact that out of the sixty firms represented at the Exhibition most were British. Those who took part in industrial enterprise of any importance, he said, knew very well that if they were less efficient their costs would be higher, their outputs lower, and they would suffer in competition with rivals. With the world moving towards larger units, the larger outputs and quantities required the fullest use of mechanical office assistance, and the latest improvements that intensive thought could provide were absolutely essential to control the larger units. The result of the movements into the larger units would be stability. Stability had to be achieved on a new basis of price levels. Some business men had complained of Government interference, and wanted to be left alone to get on with their jobs. It would, he suggested, be an admirable thing if that could be done, but when they looked round they found that the only cases of readjustment and improvement in the industrial world had been carried out by the Government. Instances of such improvement were to be found in the electrical industry and agriculture. Lord Melchett pointed out that unification was still unrealised in the steel, textile, engineering, and shipbuilding industries, and that the unemployment problem was still unsolved.

The Shipping, Engineering and Machinery Exhibition at Olympia.

No. IV.

(Continued from page 282, September 22nd.)

SIR W. G. ARMSTRONG, WHITWORTH AND CO. (ENGINEERS), LTD.

In the pages of THE ENGINEER, frequent reference has been made to the various products of Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., of Scotswood Works, Newcastle-upon-Tyne, especially with regard to oil-electric traction. Unfortunately, and partly owing to the wide range of manufactures undertaken by the firm, it was found impossible to exhibit at Olympia more in this line than the small oil-electric shunting locomotive illustrated in Fig. 84. The main dimensions of this 0-4-0 locomotive are given in the following table :—

Wheel diameter..	2ft. 9in.
Wheel base	6ft. 3in.
Total weight (working order)	15 tons
Length over buffer beams	13ft. 4½in.
Maximum width	9ft.
Height to roof	10ft. $10\frac{11}{16}$in.

In the frame construction, which is a structure similar to a box girder, considerable use has been made of welding with the object of eliminating the possibility of members working loose. The buffer beams are mild steel plates reinforced by iron castings, which also serve as ballast to give the necessary adhesive weight. Laminated springs of plain, rectangular section are placed inside the frame over the axles.

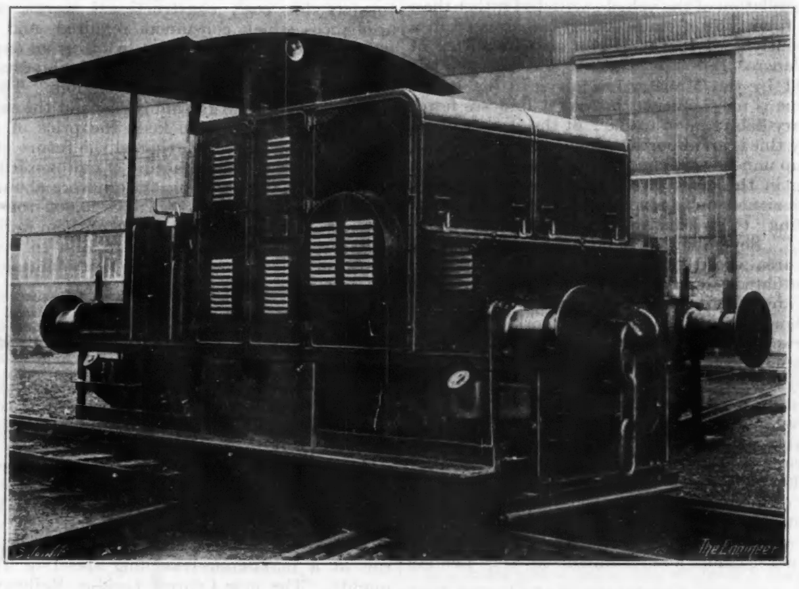


FIG. 84—0-4-0 OIL-ELECTRIC SHUNTING LOCOMOTIVE—ARMSTRONG

Since the engine is of the standard Armstrong-Saurer six-cylinder type, which has been described on previous occasions, it is not necessary to refer to it in detail here. It is direct-coupled to the electric generator and the crank case is bolted to the generator frame. The power unit so formed is carried by three trunnions in rubber-bushed bearings on the locomotive frame. The object of this arrangement is not merely to isolate the locomotive from any vibration, but to protect the power unit from the effects of any strains in the main frame. Compared to the standard engine an over-size sump is fitted. The large oil-cooling surface thus obtained, combined with the large capacity, is found to keep the oil at such a temperature that no special cooler is required. As might be inferred from the engraving, the power unit is mounted with its length across the locomotive, the radiator being on the left-hand side. The traction motor is supported and positively located on cross-stays, and drives the coupled axles through a jack-shaft situated between them.

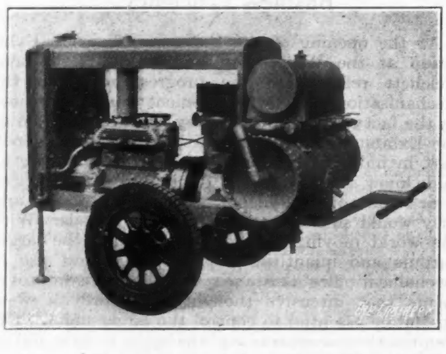


FIG. 85—PORTABLE COMPRESSOR—ARMSTRONG

The manifest advantages of an electric transmission for a "shunter" has led the makers to design a special transmission system known as the A.B.E., which, besides being simple in operation, has the additional merit of being cheap to manufacture. It consists essentially of two electric machines with special windings, a generator and a motor. A special winding on the generator is utilised for starting the engine. Practically the full engine horse-power can be taken through the generator throughout its range of speed owing to the special nature of its windings, and, consequently, any tractive effort required can be obtained merely by opening the engine throttle. Thus, in starting a heavy load the engine speed can be progressively increased until the locomotive moves steadily away with the load. In operation the controls are first unlocked by a small key, the "reversing" switch is then moved to the position "charge," and the "control handle" to "glow", warming the cylinders by glow plugs. After a minute or so, the control handle is moved to "start," when the engine is rotated by the starting battery and commences to fire. The control handle is then moved to "idle." Next the "reversing" switch is placed either in "forward" or "reverse," according to the direction of motion required. Operation of the control handle in much the same way as the accelerator of a motor car will then cause the locomotive to move smoothly away. Almost at once the engine will accelerate up to full governed speed and develop its full horse-power for starting and moving the load. All the controls are duplicated on each side of the footplate, so that the driver can move from side to side. This locomotive was running on a short length of track at the Exhibition, and nearby there was a complete A.B.E. transmission unit laid out for inspection by those interested.

Latterly, the interest of the engineering profession in this country has been concentrated on Armstrong-Whitworth's endeavours to develop the oil-driven vehicles for the railways, and the activities of the firm in other directions has tended to be overlooked by all but those directly interested in such products. In Fig. 85, therefore, we illustrate a neat, new portable compressor unit, introduced at the Exhibition and destined, we understand, to be the forerunner of a complete range of such units. It is capable of delivering 120 cubic feet of free air per minute, against a pressure of 100 lb. per square inch, and runs at 1200 r.p.m. This high rate of revolution has been made possible by so designing the compressor—see Fig. 86—that the delivery valve occupies nearly the whole area of the cylinder head, while the suction valve is placed on the top of the piston. The air velocity through the ports, as given to us by the makers, is 110ft. per second, the lift being 0·06in. The valves are of the inertia-operated ring type, and the clearance volume is 2 per cent. Air passes from the inlet manifold to an annular chamber surrounding the cylinders, and on the downward stroke of the piston is drawn upward through ducts in the body of the piston itself. In the general design of the machine, as many components of the Armstrong-Saurer engine have been used as possible.

An ingenious system of unloading has been devised. As can be seen from the lower drawing in Fig. 87, there is at the side of the twin-cylinder block a chamber containing a tubular valve. This valve is so arranged that its rotation can put the two cylinders into connection with a common transfer passage. Thus, in the fully unloaded position, the air is passed backwards and forwards between the two cylinders. For starting the engine, a hand control wheel is fitted to the end of this valve, which may thus be placed in the "unloaded" position temporarily.

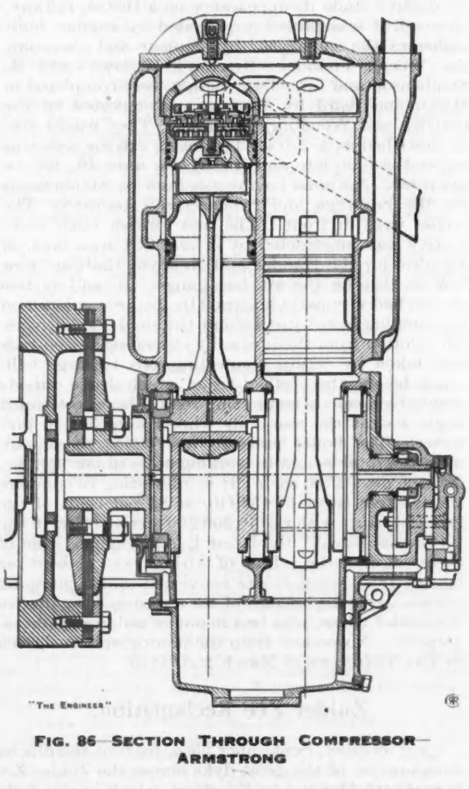


FIG. 86—SECTION THROUGH COMPRESSOR—ARMSTRONG

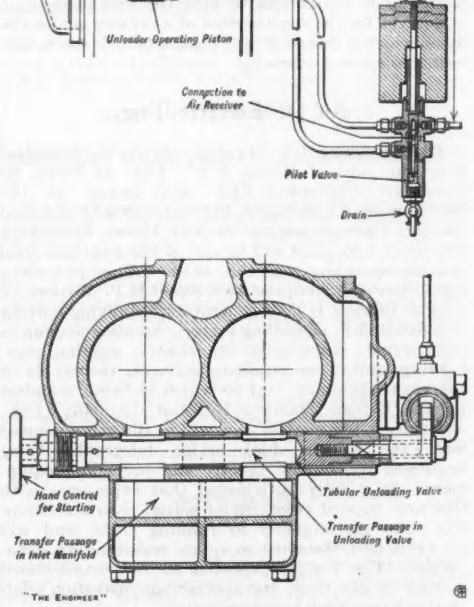

Needle Valve Controlling Rate at which Compressor is Loaded. This Permits Engine To be Speeded up Before Loading. Easing Down Engine and Unloading Compressor take Place Simultaneously
Connection to Engine Throttle Control
Unloader Operating Piston
Connection to Air Receiver
Pilot Valve
Drain
Hand Control for Starting
Tubular Unloading Valve
Transfer Passage in Unloading Valve
Transfer Passage in Inlet Manifold
"The Engineer"

FIG. 87—MECHANISM OF COMPRESSOR UNLOADER—ARMSTRONG

The upper drawing in Fig. 87 shows how the valve is operated. Air from the receiver and, therefore, under pressure, acts upon the underside of a weighted pilot valve. If the pressure builds up sufficiently for this pilot valve to be raised, air from the receiver is able to find its way through a connecting pipe to the operating cylinder on the side of the compressor block, and acting beneath the piston therein raises it. By the same motion of the pilot valve the upper chamber of the operating cylinder is placed in connection with the atmosphere *viâ* a ball valve. A third operation is also performed by the motion of the pilot valve. Pressure air passing into a connecting pipe operates a suitable device which throttles down the engine. The reverse operation of reloading is complicated by the necessity for opening the throttle of the engine before the compressor is put on load again. On the reduction of pressure in the receiver the weighted control piston falls. The pipe line to the engine throttle is then opened to atmosphere, and the engine begins to gather speed. The space beneath the piston in the operating cylinder is also opened to atmosphere, while a pipe connection brings pressure air to an "annex" above the upper chamber of the same cylinder. This air, however, cannot gain access to the cylinder by the same path by which air escaped from it, for the way is blocked by the re-seated ball valve. It is forced to find its way past a cone valve, which may be adjusted by an external nut to give a suitable period of delay.

Varley Pumps and Engineering, Ltd.

Two years ago we described and illustrated the action of the Varley pump—see Fig. 88—manufactured by Varley Pumps and Engineering, Ltd., Acton, London. This pump is positive in action and its "displacer," it will be remembered, has a paracyclic motion, the movement being imparted to it by two cranks geared to a common driving shaft and all encased with the pump itself. According to the makers, the pump can, when wet, but not full of liquid, give a vacuum equivalent to 24in. of mercury, and when fully primed can produce a vacuum of 29in. under normal barometric conditions.

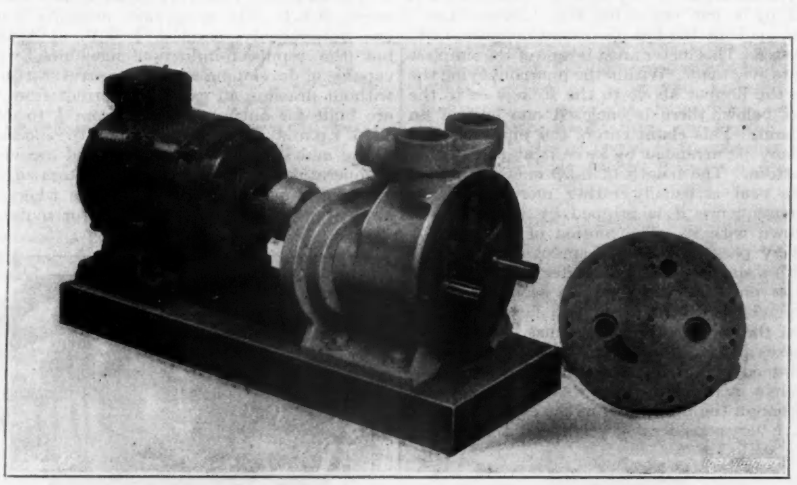


Fig. 88—Motor-Driven Positive Displacement Pump—Varley

In every pump there is included in the front casing the compensating device illustrated in Fig. 90. It will be seen that it consists of a spring-loaded piston working in a cylindrical chamber. The face of the piston is exposed to the discharge pressure and the back to the suction conditions. Its function is to absorb any slight fluctuations of flow of the liquid on either the delivery or the suction side, and it gives, it is claimed, a smooth flow without the use of air vessels.

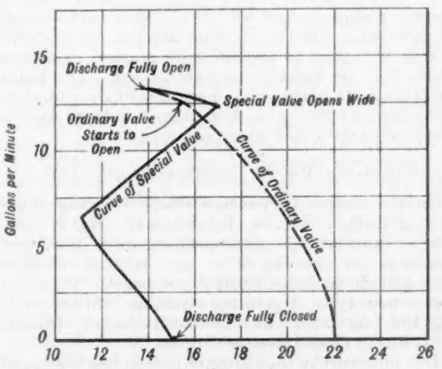


Fig. 89—Characteristics of By-Pass Valves—Varley

For use where the pump is utilised for pumping petrol from underground tanks, a special form of by-pass valve has been developed. The makers found that with an ordinary spring-loaded valve it was impossible to obtain full by-pass conditions without the pressure rising to 40 per cent. above the ordinary delivery pressure. Apart from the loss of efficiency entailed by this rise of pressure, it has a limiting effect upon the maximum delivery of the pump in districts, of which there are several, where it is not permissible to use a driving motor for petrol pump service of more than ½ H.P. In the graph reproduced in Fig. 89 the characteristics given by the maker's special by-pass valve are compared with that of an ordinary by-pass. It will be seen that the ordinary valve sends up the delivery pressure from 14 lb. to 22 lb. per square inch. The new by-pass does not begin to open at once when the discharge nozzle of the delivery pipe begins to close, but when it does, it opens fully and causes the pressure to drop rapidly to about 11 lb. per square inch, with a corresponding reduction of the quantity discharged through the delivery pipe. Subsequently with the by-pass full open the full by-pass occurs at 15 lb. per square inch. We understand that this result is obtained by the use of that type of valve which provides, when closed, a smaller area for the pressure to act upon than when open.

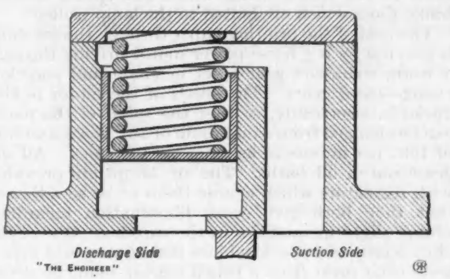


Fig. 90—Compensating Device—Varley

New Process Welders, Ltd.

Spot welders of various types and suitable for heavy and light welding were exhibited by New Process Welders, Ltd., of Scotts-road, Southall, Middlesex. Machines rated at 2 and 4 kVA are supplied for bench mounting, but if desired they can be mounted on fabricated light steel pedestals or stands; whilst 8 and 16 kVA welders are mounted on cast iron pedestals, as shown in Fig. 91. The primary of these machines is wound on the ring or gramme principle, and is entirely distributed around the core. Two bronze castings encase the primary winding and core, and form a single turn secondary winding which supplies current to the electrodes, one-half of the casing being stationary and the other movable. In Fig. 92 A is the stationary part of the secondary and B the moving part attached to the movable electrode; C is the iron core with an axle in the centre.

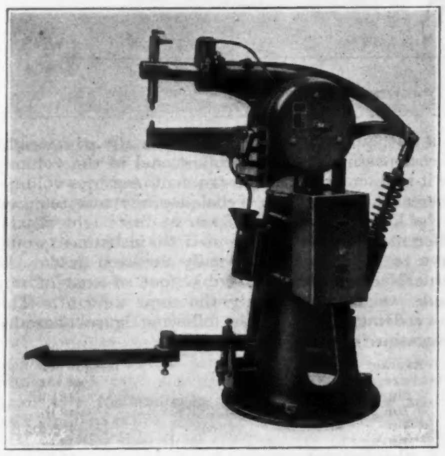


Fig. 91—Spot Welder—New Process Welders

The fixed electrode is, of course, attached to the fixed part of the casing. With this form of construction magnetic leakage is said to be completely eliminated and with standard arms the power factor is over 0·9. In the case of the 2-kVA machine, the electrode arms are cast solid with the bronze casing, whilst on the 4, 8, and 16-kVA machines the lower arm is bolted to a T-slotted face plate cast solidly with the fixed half of the transformer secondary and can be moved up or down or sideways. The upper arm on these machines is telescopically mounted on the moving part of the transformer, and the foot pedal operates on the moving part of the secondary through an adjustable spring and switch. The primary winding is provided with from three to five tappings for slightly varying the secondary voltage to meet requirements.

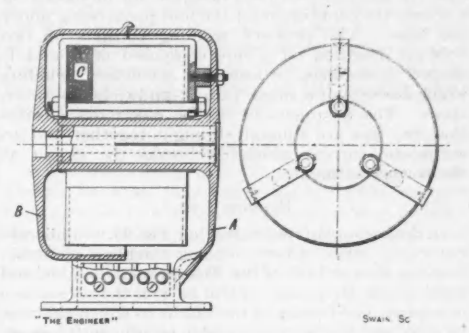


Fig. 92—Details of Welding Transformer

The most interesting feature of these spot welders, however, is the automatic controller, which enables higher voltages to be used than usual, and consequently makes it possible to increase the welding speed. It can easily be adjusted to meet variations of materials, and enables unskilled operators to make perfect welds. Controllers of this type are also supplied separately for use with any other make of spot welder. The principle of the "D" type controller, as fitted to the 8 and 16-kVA spot welders, will be understood from Fig. 93. After the initial movement of the machine pedal has closed the welding tips on to the work, further movement applies the spring pressure and afterwards the pedal contacts A are closed. This energises the contactor coil B, which attracts the rocker arm of the contactor and closes the circuit at C, thus energising the transformer, and the work between the electrodes is welded. When the weld has been correctly made, the reduced resistance gives rise to a current surge in the electrode arms, and the contacts D of a magnetic relay are closed, thus energising the coil E of an electric relay in the controller case. The arm of this relay is therefore attracted, and breaks the contactor coil circuit at F, whilst the sustaining switch G closes and keeps the relay coil energised so that the contactor remains in the "off" position until the pedal is lifted. The release of the pedal breaks the relay coil circuit at A, and the controller is automatically reset for the next weld. Naturally the time taken to complete a weld

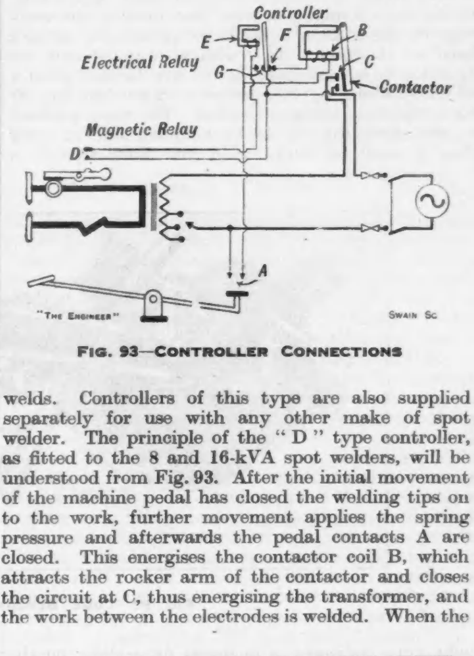


Fig. 93—Controller Connections

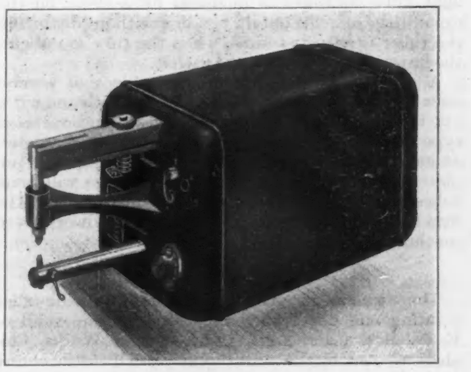


Fig. 94—Bench Spot Welder

depends on the thickness of the metal, and by means of a cam which controls the gap between the iron ring which surrounds the upper electrode and the magnetic relay armature, the necessary adjustments of the relay can easily be made. Graduations on the cam facilitate the subsequent resetting of the machine.

An entirely new spot welder developed by the firm for use in connection with the manufacture of electric lamps, wireless valves, and for light wire and sheet metal work is shown in Fig. 94. It will be gathered that the machine has been designed for mounting on a bench, the connection for the foot pedal being under the base. The primary winding consists of two bobbins mounted on a core composed of E and I-shaped stampings, whilst the secondary winding which consists of a single turn is sandwiched between them. The arrangement of the electrodes ensures that the tips are squarely brought together and an automatic current controller breaks the circuit at the correct moment.

HILMOR LTD.

In the accompanying engraving, Fig. 95, we illustrate one of the range of tube bending machines manufactured by Hilmor Ltd., of 108, Euston-road, London, and exhibited at Olympia. It will be seen that it consists of a wheel-like former of the radius to which the tube is to be bent and interchangeable rapidly with formers of different sizes, a bending arm carrying a roller, and a guide, formed with a slot of the diameter of the tube to be bent, which fits between the roller and the tube. In action, of course, pulling back the arm causes the tube to be bent around the former. The machine is equipped with a special patented feature. It will be seen that the position of the roller relative to the arm can be varied by a screw and nut motion. Thus, for any particular tube and former the arm can be placed in any position over quite a wide arc before the tube was bent. Referring to the engraving, the nearer the arm approached the observer before bending commenced, the easier would it be to bend the tube owing to the higher leverage about the point of bending. It has been found, however, that making the work easy in this fashion is liable to wrinkle the interior bend of the tube. In a similar way, should the operator be so unhandy as to give himself greater effort by arranging the arm to start bending too far back, the tube will be distorted. The mean position is, therefore, the one to be adopted, and in order that it may be found with the least trouble a light brass indicator is mounted on a slider on the top of the arm. To obtain bending without distortion the roller is adjusted until, when the tube is unbent, the brass indicator is parallel with it.

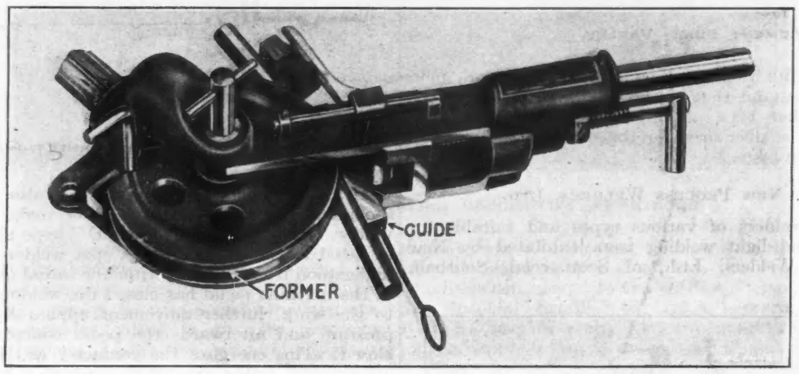


FIG. 95—TUBE BENDING MACHINE—HILMOR

A number of hand-operated machines of several sizes were to be seen on the stand, both with and without the indicator device. The largest hand-operated type will bend copper tubes up to 2in. in diameter, 16 gauge, without filling, and steel tube up to 1½in. diameter, while the smallest of the range will bend tubes ¼in. outside diameter to a radius of ¾in. The firm also makes ratchet-aided and power-driven machines.

E. N. MASON AND SONS, LTD.

There was an extensive collection of drawing-office printing and developing apparatus on the stand of E. N. Mason and Sons, Ltd., Arclight Works, Colchester. Among the most recently produced machines is the New Century continuous photo-copier, shown in Fig. 104 on page 310, which has been specially designed for printing the new style of dye-line prints that need a very even distribution of exposure to the light. This machine is made in two styles, one with a single arc lamp and the other with two. That illustrated is of the latter type. The lamps run on tracks so placed that the arc crater is at the centre of curvature of the bent glass developing platen, so that there is an even distribution of the light over the whole surface. They are driven, independently, by little one-twentieth horse-power electric motors, mounted on the lamp carriage. The power is transmitted through worm and worm wheel gearing to a crank which operates in a specially shaped crosshead, providing for a uniform movement across and "dwell" at the ends of the run, in order to compensate for the lack of "back rays" at the edges of the print. In order to overcome the natural momentum and to bring the lamp trolley to rest without shock, two adjustable brakes are fitted. These brakes comprise curved steel tracks fixed to the frame along which run spring tension brake shoes which are bolted to the lamp trolley.

The feed of the printing paper through the machine is effected by a ¼ horse-power motor driving through a worm reduction gear a set of chain and sprocket change-speed gears. The speed of the motor is also variable, electrically, so that the speed of the paper can be changed from a minimum of 2in. to a maximum of 15ft. per minute in as many as 100 steps. All the gears run in oil baths. The arc lamps are provided with regulators which enable them to be so adjusted that they both give equal illumination regardless of any slight inequalities in the carbons. One of the chief merits of these machines is that they will give a good clear print from a pencil tracing made on detail paper.

Besides several other types of printing machines, there were on this stand a number of developing machines, print trimmers, and other accessories of the drawing-office.

THE LEA RECORDER COMPANY, LTD.

On the occasion of the last Shipping, Engineering and Machinery Exhibition at Olympia we described and illustrated by a line engraving the "Romer Lea" coal meter, made by the Lea Recorder Company, Ltd., of Manchester. This meter must be one of the simplest instruments ever made. Within the pipe conveying the coal from the hopper above to the stokers or to the pulverisers below, there is enclosed one half of an endless chain. This chain enters the pipe near the top and may be arranged to leave it at the side or at the bottom. The length of its immersion in the descending coal is usually rather more than 6ft., and in consequence it is gripped by the coal and carried down with it. The motion of the chain is measured by passing it over a sprocket wheel connected with a suitable form of counter.

It will at once be seen that the accuracy of the meter depends in the main on two factors. First, the grip of the coal on the chain must be such that no slip takes place. That that desiradatum is certainly attained was easily proved by a visit to the stand where a meter of the type was shown in operation. Although the immersion of the chain was only about 4ft., a very considerable weight could be applied to it without any sign of slip. Secondly, the weight of coal passing must be proportional to the volume, for it is obvious that the instrument measures volume, whereas it is the weight of coal passing that is required to be known. It might seem at first sight that if different grades of coal were used, the instrument would have to be calibrated specially for each grade. In actual fact, however, a cubic foot of coal of any grade weighs very nearly the same amount. This fact is demonstrated by the following figures of graded Lancashire coal:—

Average size.	Weight per cubic foot, dry.
2in.	48¼ lb.
1in.	48 lb.
½in.	48¾ lb.
¼in.	46 lb.
Peas and dust	47 lb.
Average	47·6 lb.

Nor is the variation of weight per cubic foot of different classes of coal very great. The average weight per cubic foot of seven coals from different districts was found to be 48·1 lb., the highest figure being 52·1 for Welsh and the lowest 46·8 for Derby coals. It will be seen therefore that this method of measurement by volume can be accurate. It also has the advantage of being totally unaffected by surface moisture, for the water contained in the coal which may have so large an effect if the material is weighed, has no influence upon its volume.

Another instrument which was exhibited on the stand is intended for the measurement of water flow. It is illustrated in Fig. 103, page 310. A float in the tank from which the water flows over a calibrated weir or V notch carries an upright bar. On the bar are mounted the two small gear wheels of the well-known "Lea" integrator. It will be remembered that this integrator consists of two drums cut with gear teeth, one of which is driven at a constant speed. In the instrument under discussion a tiny synchronous A.C. motor operated from the supply mains is used. The gear teeth do not cover the whole surface of the driven drum, but are cut away in a form more or less that of a helix, and depending upon the characteristics of the weir, V notch, or orifice, &c. Thus, at the top there are gear teeth all round the drum, and at the bottom no teeth at all. Connection between the two drums is made by two small intermeshing gear wheels, one of which meshes with the driven drum and the other with the second drum which is connected to a counter, the mechanism of a recording pen, or in any other way required. Thus upon the position of the two small gear wheels depends the proportion of the time during which the second or recording drum is rotated by the driven drum. In the instrument under review the small wheels are mounted on a rod attached directly to the float, while the box in which the mechanism is contained bears in its top a counter.

Many others of the various instruments made by the firm were to be seen on the stand.

POWER CONTRACTS (BATWIN), LTD.

A display of split-phase, induction-repulsion, D.C., and capacitator motors was to be seen on the stand of Power Contracts (Batwin), Ltd., of 138, Southwark-street, S.E.1. The split-phase machine is made for one output only, namely, ¼ H.P. at 1428 r.p.m., but the repulsion-induction machines, which are capable of developing a very powerful starting torque without drawing an excessive current from the line, are built for outputs ranging from ⅙ to 3 H.P. at 1425 r.p.m. They are fitted with special brush-lifting and short-circuiting gear, and are very silent in operation. Spring-mounted motors of ⅙ and ¼ H.P. are supplied for use in places where absolute silence is required. The capacitator motors, which are also claimed to be absolutely silent in operation, are provided with an electrolytic condenser, and are said to work with an excellent power factor and efficiency.

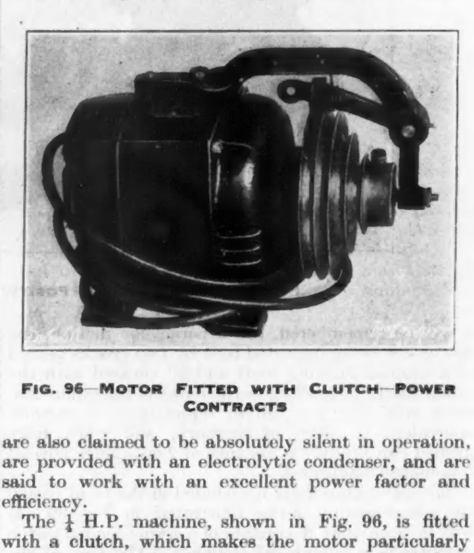


FIG. 96—MOTOR FITTED WITH CLUTCH—POWER CONTRACTS

The ¼ H.P. machine, shown in Fig. 96, is fitted with a clutch, which makes the motor particularly suitable for driving sewing machines, coil winders, &c., which demand considerable speed variation. The clutch unit incorporates an aluminium pulley with two different sized grooves. The driving member makes contact with the driving part through a leather ring, and the pressure upon it can be varied at will according to the pressure applied to a lever which may be hand or foot-controlled. The motor shown is a standard split-phase machine, wound for 220 volts and 50 cycles, but other windings may be provided to meet special requirements.

PRECISION PHOTO PRINTING PLANT, LTD.

On the stand of Precision Photo Printing Plant, Ltd., Salisbury House, London-wall, E.C.2, there were a number of photo-printing and developing machines for drawing-office use, several of which have already been described in our pages. There was also a new type of printing machine, illustrated by Fig. 102, page 310, which has been specially designed for printing Ozalid positive copies.

It is noteworthy that some objection has been made in the past to these positive prints, when made on wide paper in the normal travelling arc lamp machine, on account of a striped effect at the edges, which may be so acute as to make the print difficult to read. This effect is produced by the lack of sufficient exposure to the light at the edges of the print where the lamp reverses its travel, but has been overcome in the case of the machine under review by the simple expedient of slowing up the speed of travel of the lamp at each end of its stroke. The lamp is mounted on a carriage and is moved by a chain running over sprockets on either side of the machine. One of the sprockets is driven by a little electric motor and three-speed gear-box by a crank pin on a shaft engaging with a slot in a disc on another shaft. The two shafts are set out of alignment, so that as the pin drives the disc round it must slide in the slot and consequently hasten the travel of the lamp during the middle part of its stroke, and slow it up at the ends. At our request, some tracings, which were not very clearly made, were copied in the machine and developed, and we found them in each case as well defined as the original.

CHARLES WESTON AND CO., LTD.

On the stand of Charles Weston and Co., Ltd., of Lincoln Chambers, Portsmouth-street, London, W.C.2, there was shown a wide range of "Gits" oil seals, the efficiency of this fitting being demonstrated by a bearing running in water, which showed no trace of oil leakage from the sealed bearings. A practical example of the application of the oil seal was seen in a 10in. worm reduction gear by Henry Wallwork and Co., Ltd., of Manchester. Two examples of the use of oil seals are illustrated in Fig. 97 herewith. The seal is a ring formed of a heavy steel metal pressing of rectangular cross section, the outside diameter of which is finished to a tolerance of plus or minus one-thousandth of an inch, thereby ensuring an oil-tight joint when the seal is pressed into the bearing housing. As the drawing clearly indicates, the sealing element consists of a leather ring of special shape, which has a long tapered lip at its inner edge. This lip is pressed against the shaft by a spring-loaded, cone-shaped washer, which also serves the purpose of shearing off the oil film and preventing the escape of oil from the casing. The firm also showed examples of "Raymill" grub and cup screws, which are furnished with an hexagonal hole on the head of the screw, in which a tommy bar of hexagonal section is used, and are supplied in different metals and patterns. Various types of "Gits" oil cups and wick feeds for special purposes were also on view.

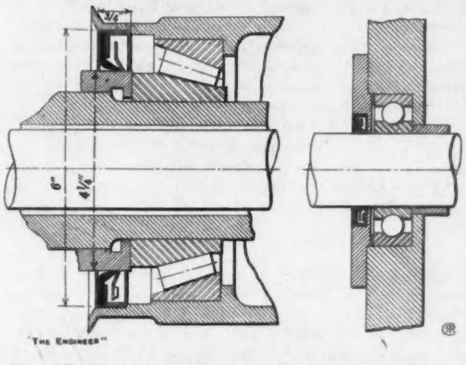


FIG. 97—ARRANGEMENTS OF "GITS" OIL SEAL—WESTON

MARINE ELECTRICAL EQUIPMENT COMPANY, LTD.

Wireless apparatus for use at sea was shown by the Marine Electrical Company, of Gambrell Works, Merton-road, Southfields. The firm's $\frac{1}{2}$-kW (anode rating) radio-telegraph marine installation is claimed to cover ranges on interrupted continuous wave telegraphy equal to those obtained with much more powerful sets, and to meet all requirements in the 600 m. to 800 m. band, even in the case of large vessels. Provision is also made for continuous wave transmission. The main controls include the transmit-receive switch, a combined CW/ICW full-power/reduced-power switch, and voltage controller, together with a volt-meter and aerial ammeter, all mounted above the receiver and directly in front of the operator. The transmitter wave length can be changed instantaneously by the movement of a single switch, while a separate control enables a small change of wave length to be made under heavy interference conditions. Power is obtained from a motor alternator set designed to suit the ship's D.C. supply, and normally fitted in a cupboard under the operator's table, together with an automatic starter, the starting switch and field regulator being mounted on the control unit. The A.C. supply system is used in preference to the generation of high-voltage D.C., owing to the difficulties generally experienced with high-voltage commutators at sea. Provision is made for emergency working as required by the Board of Trade.

The receiver complies with the regulations for compulsorily fitted ships and meets all the requirements for normal marine working. It covers a wave range of from 15–20,000 m. without sacrificing efficiency on any particular wave length, and gives ample selectivity. Special arrangements are incorporated to eliminate broadcast transmissions and other interferences when receiving on the 600–800 m. wave band. An efficient volume control is also provided. The full wave range is obtained by the operation of the wave change switch without changing coils. Limitations of space will not allow us to describe all the wireless apparatus shown by this firm, and it must suffice to refer to some of the remainder of the exhibits very briefly. A short-wave transmitter attachment shown has been developed to form an addition to the standard radio-telegraphic installation described, and in combination, where necessary, with a long wave attachment, it will not only cover all marine telegraphic requirements, but is said to make the complete apparatus far more economical and efficient in working than a main high-power installation. When a complete short-wave equipment is required to work independently of the main medium wave apparatus, the short-wave attachment mentioned is supplied as an independent installation, with motor alternator control and power units and receiver.

The equipment shown in Fig. 105, page 310, is capable of a performance similar to that of the standard radio-telegraph set described, and is also capable of transmitting speech over a distance of 400 miles or more, according to the type of aerial employed. It is therefore suitable for whaler and trawler depôt ships, which need to communicate on telephony with stations which do not have skilled operators, in addition to working on the normal ship-to-ship and ship-to-shore service on 600–800 m. The receiver may be of a simplified type, covering a restricted wave range, but the standard 15–20,000 m. receiver is supplied if required. Provision for emergency working is made when necessary and the transmitter wave range is capable of adaptation to the particular service. Other exhibits were a low-power radio-telephone installation for communication with the Post Office coast stations, a lifeboat installation, a long-wave receiver, a mobile radio-telegraphic-telephone equipment, and the marine direction finder shown in Fig. 106, page 310, in which the rotating loop system has been adopted on account of its simplicity and freedom from errors. The aerial winding is enclosed in a heavy copper tube forming an octagonal frame. In order to facilitate operation, and to enable bearings to be taken accurately and rapidly, the receiver is mounted on the lower tube above the scale and hand wheel, and directly in front of the operator. The receiver is said to be highly sensitive and selective, and to enable bearings to be obtained within half of a degree. A small vertical aerial is used, in addition to the frame, and "sense" is determined by a simple device. After calibration, quadrantal errors are marked on a dial adjacent to the bearing scale, thus enabling the operator to determine the corrected bearing without referring to charts.

SUPER-CENTRIFUGAL ENGINEERS, LTD.

Two centrifuges, both shown by Super-Centrifugal Engineers, Ltd., of Sharples House, Grosvenor-road, London, are illustrated in the engravings Fig. 101 on page 310 and Fig. 98. One is for large-scale production purposes, while the other is intended for use in the laboratory. The big machine has a basket 65in. in diameter, and it is capable of operating continuously, automatically discharging the solids while the basket is running at full speed. Either the solid or the perforated type of basket may be fitted. As a drainer this machine is applied to the dehydration of crystals and granular materials, while the sedimentation principle with a solid basket is applied in those cases where the suspension in a liquid has poor filtering qualities; for example, where the particle size is very small or is of a slimy nature.

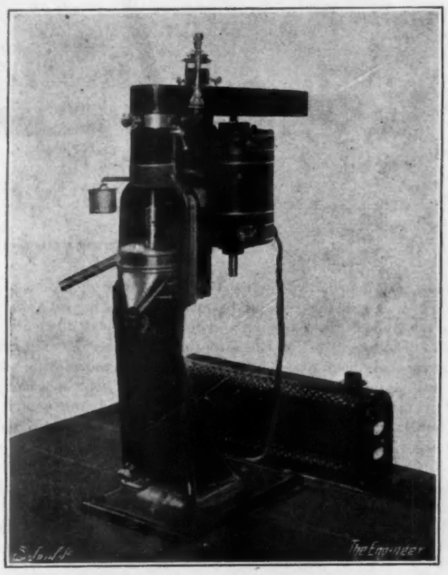


FIG. 98—LABORATORY CENTRIFUGE—SUPER-CENTRIFUGAL

Whilst the basket of the machine is operating at its full speed, the dried crystals can be unloaded and discharged automatically through a chute, in the bottom of the machine, by a simple mechanical operation of a knife gear driven from the main shaft. This gear is to be seen on the upper right-hand side of the engraving. When operating as a sedimenter, the supernatant liquid is removed from the basket of the machine continuously, without reducing speed, by the special decanting pipe, the controls for which may also be seen in the engraving. The material to be treated is fed into the machine on to the lower periphery of the basket. That portion of the feed inlet pipe projecting into the basket is varied in shape according to the problem to avoid turbulence in the liquid layer, especially when the separation of colloidal substances, such as sludges, is called for and where any turbulence must be rigorously avoided. It is claimed that by variation of the design of the inlet pipe and automatic decanting gear a perfectly clear supernatant liquor can be obtained..

The little centrifuge for laboratory purposes is driven by a $\frac{1}{4}$ H.P. electric motor at a speed of approximately 30,000 r.p.m., and the centrifugal force obtainable is about 40,000 times the force of gravity. Three types of bowl may be fitted. All are 2in. in diameter by 9in. long, and hold about 300 millilitres of liquid. They are fed from below on the axis of spin. The clarifier bowl has one central outlet at the top and is used for the removal of suspended solids which are retained in the bowl while the liquid is run off. A separator bowl with two outlets at the top, one central and one draining from the side of the bowl, may be used for the separation of emulsions of immiscible liquids. The third type of bowl has no outlet and is arranged for handling small amounts of liquid in batches.

BENTLEYS.

When describing the Thornycroft-built motor yacht "Trenora" in our issue of August 4th, we made brief mention of a new low-pressure system of sewage ejection for marine purposes which was designed and fitted by Bentleys, of Hull-road, York. A pair of ejector units arranged either for marine or land service were exhibited by the firm at Olympia. They are illustrated in Fig. 100 on page 310. The ejector is of an improved pattern, for which patents are pending, and it works at a lower air pressure than is generally used for sewage ejection. The supply of injection air is automatically controlled by electrically operated solenoid mechanism, which is small and compact. The whole of the plant, as will be seen from our illustration, takes up very little space, and is complete with its own motor-driven compressor, and forced feed lubrication to all working parts. By means of the individual motor drive, the ring main system of air supply is entirely dispensed with, and a further economy in operating air is effected by the adoption of a closed circuit air system, which has also the great advantage that there is no discharge to atmosphere of the operating air from the injector unit. Special arrangements are made for independent operation of either injector units or their working together. The "Trenora" plant is operated by a $\frac{1}{2}$ horse-power motor, and is designed to deal with 2000 gallons of sewage and waste water per hour. A slightly larger capacity plant was exhibited at Olympia, and was shown in actual operation, the practically noiseless working of the units being a noticeable feature.

GENERAL POST OFFICE.

The British Post Office was showing an interesting collection of electrical communication apparatus. There were examples of private branch telephone exchanges which provide facilities for internal communication in offices, works, &c., and for connection with the public telephone system. Visitors to the Exhibition were able to send radiotelegrams free of charge to friends on board passenger ships of the British mercantile marine, which can be reached through British Post Office stations. Among the exhibits of more technical interest was a voice delay apparatus designed to give a second and a-half delay between transmission and reception. The apparatus consists of a steel tape band driven by an electric motor. A coil surrounding the tape is connected to a microphone and amplifier, and speech currents in the former produce a magnetic field in the tape, which passes through a reproducing coil. The varying field acting on this coil produces a varying voltage which is amplified and applied to a loud-speaker, the tape being subsequently demagnetised by means of a 7000 cycle oscillating coil.

Cable pairs to London-Southampton, London-Bristol, London-Cardiff, Cardiff-Birmingham, and Birmingham-London were joined together to form a 1000-mile circuit. Arrangements were made to enable visitors to test the telephonic properties of the line, which proved to be remarkably good. The apparatus at Olympia was fitted with an echo suppressor, and a repeater, which could be switched in and out, in order to demonstrate their effects as regards volume and audibility. Experience has shown that on such long circuits an echo suppressor is essential, as in its absence the echo is so bad that normal conversation is impossible. Fifteen repeaters were included in the circuit.

Two teleprinters were shown for "telex" service, in which the subscriber asks for or dials a telephone number in the ordinary way, and on being connected asks the subscriber at the distant end to switch in teleprinter. The message is then typed by the calling subscriber and is reproduced on the teleprinter at the other end of the line. As the signals consist of a combination of impulses using 300 cycles as the basis tone, there is no difficulty in using teleprinters on ordinary telephone lines. In addition to the commercial apparatus, a loud-speaker and oscillograph were connected across the line to enable visitors both to see and hear the transmitted impulses.

Various types of submarine cables were on view, including a sample of the discontinuously loaded trunk channel cable. A model of the cable ship "Monarch" was also exhibited. Other exhibits relating to telephony were automatic telephone apparatus and a radio speech secrecy device. To obtain secrecy on overseas radio telephone calls, bands of speech are filtered and interposed according to pre-arranged codes, which are changed at frequent intervals, with the result that listeners other than those actually using the system are unable to interpret the messages.

A mercury vapour rectifier shown has been designed for use with valves requiring a high-tension D.C. supply of approximately 10,000 volts. Its special feature is its high efficiency as compared with that of an ordinary vacuum-type rectifier, owing to the low anode cathode impedance brought about by the bombardment of mercury molecules by negative electrons given off by the cathode. More negative electrons are knocked off each molecule than the number which bombard it, and the emission is therefore increased, whilst displaced positive ions are attracted to the cathode, thus partly neutralising the "space charge." The net result is a considerable reduction of anode-cathode impedance, with a resultant reduction of wasted power. The bombardment of the cathode by positive ions, however, tends to shorten its life, and the proportions of the cathode are, therefore, made relatively massive, and it is generally worked at low voltage and with heavy current.

Among the valves shown for use in transmitters was a 500 kW unit for working at anode pressures up to 18,000 volts, and as used in the Rugby wireless station for world-wide communication. It has six filaments, each consuming 75 ampères at 32 volts, the emission being 100 ampères, and the amplification factor 45. The copper cylindrical anode, which is 8in. in diameter and 22½in. long, is cooled by a water jacket, the water being distilled to reduce electrical leakage. The grid connection is led out at the side of the glass bulb, and the grid itself is supported by four cylindrical quartz insulators. The glass-copper seal between the anode and envelope is cooled by an air blast in order to prevent any tendency to fracture as the result of the difference in the coefficient of expansion of copper and glass. As a further safeguard extremely thin copper is used. While the grid connection is not artificially cooled, the filament seal is cooled by means of water.

Another interesting valve was a 500-watt "Heptode" valve, as used as an amplifier in short-wave transmitters. The object aimed at in the design of this valve has been to prevent self-oscillation as the result of back coupling between the anode and grid, the frequency being determined by the transmitter drive which generally takes the form of a crystal. All the electrodes required by the balanced push-pull arrangement are contained in the single envelope, the general construction being very rigid to prevent any relative movement of the electrodes. The grids are composed of molybdenum and the filaments of thoriated tungsten, the filament current being 20 ampères and the emission 750 ma. The anode voltage is 3000, and frequencies up to 20 megacycles are obtained.

THE UNITED STATES METALLIC PACKING COMPANY, LTD.

Besides a fine display of rod packings and piston rings with which the name of the United States Metallic Packing Company, Ltd., Soho Works, Bradford, is familiarly associated, this firm showed some steam traps of the type illustrated by Fig. 99. This trap is intended for draining vessels at or below atmospheric pressure, and has a definite pumping action, the force for which is supplied by a separate connection to a steam or compressed air main having a pressure of about 30 lb. per square inch.

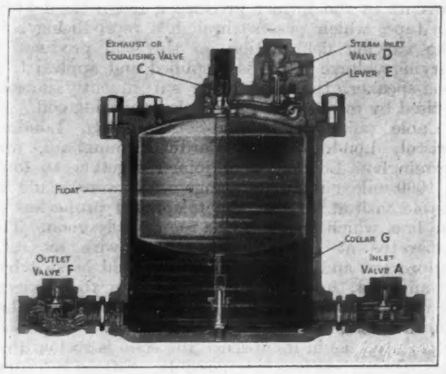


FIG. 99—STEAM TRAP—U.S. METALLIC PACKING

In the event of the vessel to be drained having a pressure below that of the atmosphere, the top of the trap is connected with the vessel by an equalising pipe, so that, with a head of, say, 2ft., the water will flow into the trap under the influence of gravity. It enters through the non-return valve A, and gradually fills the body of the trap. The float B rises with the water and ultimately closes the equalising valve C. Immediately afterwards, by pressing up on the lever E, it opens the live steam valve D. The steam then forces the water out through the non-return valve F. The float sinks again, but the equalising valve is held closed by the internal steam pressure, so that the steam cannot get back to the vessel being drained, and thus destroy its vacuum. The steam valve closes, but the expansion of the steam continues to displace the water. When the float sinks so far as to sit on the collar G, its weight pulls open the valve C, and equilibrium of pressure is re-established in the trap and the vessel. The cycle of operation is then repeated. In cases where the vessel to be drained is open to atmosphere, the equalising pipe is not required, and the valve exhausts into the open. The trap gives a quite definite discharge at each cycle and, consequently, can be used to measure the amount of condensate being handled. A convenient way of doing this is to connect a pressure gauge with the top of the trap—a tapped hole is provided for the purpose—and to count the pulsations of pressure registered. The trap is made in three standard sizes capable of discharging from 150 to 700 gallons per hour.

(To be continued.)

Letters to the Editor.

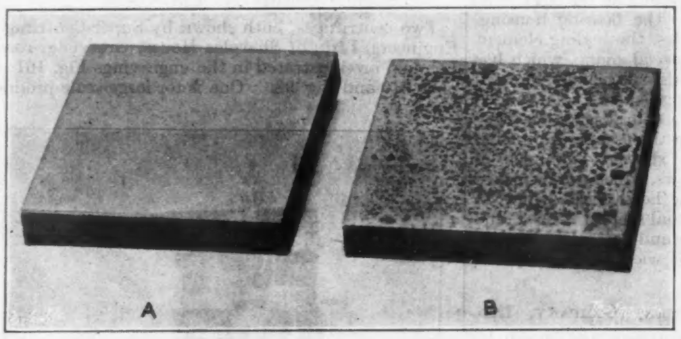
(We do not hold ourselves responsible for the opinions of our correspondents.)

CYLINDER WEAR AND LUBRICANTS.

SIR,—The Report of the Institution of Automobile Engineers Research Committee, published in your edition of June 23rd, indicates clearly the harmful effect of rusting or corrosion of the cylinder wall by moisture condensed from the products of combustion of the fuel.

The beneficial effect in reducing cylinder and piston ring wear of incorporating a small amount of free fatty acid into the lubricating oil is apparent from the engine tests described in the latter part of the Report.

This protective action of oils containing traces of free fatty acid is, of course, strictly in accord with modern chemical theory, the presence of the Polar group in the fatty acid causing the oil to adhere more firmly to the metal than is the case with ordinary mineral lubricating oils. Confirmation of the superior adhesion of such oils has recently been found by various physical measurements, notably the contact angle method and the heat of wetting of metallic powders by oil, the former test being used by Von Dallwitz-Wegener and the latter by Bachmann and Brieger. It can be shown mathematically that the adhesion of a liquid to a solid can be measured by observing the angle of contact of the liquid resting on a metallic surface—the smaller the angle the greater the adhesion. The contact angle at a metallic face is much smaller for an oil containing oleic acid than for the pure hydrocarbon oil.



TEST FOR LUBRICATING OILS

Confirmation of the greater work of adhesion by the former type of lubricant has also been found in the greater heat of wetting when finely divided metallic powders are shaken with the oil.

The photographs attached show the results of a very simple test for comparing two lubricating oils for their relative power of protecting metallic surfaces from corrosion by water. Flat polished plates are smeared with the oil and then exposed for a few minutes to an atmosphere of condensing steam (water boiling in a beaker). The plates are allowed to stand untouched over night and then washed with a solvent. The plate B has been oiled with an ordinary mineral lubricating oil and has badly rusted in spots, while A previously coated with the same oil containing 1 per cent. of a mixture of the higher fatty acids has been protected from corrosion and is almost unattacked.

J. E. SOUTHCOMBE.

Germ Lubricants, Ltd.,
Finsbury-circus, London,
September 18th.

DIVING AND THE YOUNG ENGINEER.

SIR,—Referring to the interesting article on this subject in your issue of September 15th, we would mention that we have been giving diving instruction in one of our large tanks in our experimental department here for nearly thirty years.

Many young engineers, and a few older ones, have taken advantage of the course, which includes (1) a talk on the construction and functioning of the diving apparatus; (2) a lecture on deep diving with special regard to decompression; (3) not less than three dives under the supervision of competent divers.

Usually after the third dive the student is quite capable of diving at greater depths in open water.

For the engineer who is more interested in compressed air in connection with caisson sinking, &c., we offer similar facilities, the practical part of the course in this case being given in one of our steel air lock chambers. In other sections we produce high altitude and poison gas conditions, and demonstrate the appropriate apparatus for combating them.

SIEBE, GORMAN AND CO., Ltd.,
ROBERT H. DAVIS, Managing Director.
London, S.E.1, September 20th.

SIR,—In reference to your leading article on "Diving and the Young Engineer," in your last week's issue, allow me to point out that most of the students in this School since the year 1879 have received practical instruction in diving and have obtained certificates from Messrs. Siebe, Gorman and Co., in which are embodied the following:—"has received instruction in under-water diving in our tank, and is now, in our opinion, capable of making examination of subaqueous work in connection with Harbours, Docks, Bridges, &c."

MAURICE WILSON, M. Inst. C.E.,
Principal, Crystal Palace School of
Practical Engineering.
Crystal Palace, September 18th.

MONEY *versus* MAN.

SIR,—I should like to endorse the excellent letter sent by Mr. M. Jacklin, which appeared in your issue of the 15th inst.

Money, an artificiality (*i.e.*, it is a man-made device), has become a Franckenstein. It should be the servant; it has become the master. Most of us are familiar with Mr. Norman's confession.

I believe that the engineer, who by his training is a realist, will have to tackle this problem of distribution. It is his duty to do so.

The American experiment is not being conducted by engineers, or at any rate not realistically. Pumping money into circulation on the productive side creates debts, does not proportionately increase employment (even if this were desirable), and certainly raises prices. In its present form it is bound to fail. Mr. Roosevelt is finding this out.

During the war ration tickets were issued to everybody to enable people to share in the available food supply. War makes people think and act realistically. Why cannot money be issued to everybody to take unconsumed goods and services off the market? Money is a ticket.

I suggest, Sir, you consider the suggestion that a committee of engineers be set up to consider this simple proposal and its effect on prices and how they could be controlled.

To "give money for nothing" might be a ready quip to give in reply; but it is not giving money for nothing that is proposed. The proposition is to make money distribute our surplus wealth to people who want it.

Failure to solve this problem will mean the break up of our civilisation.

R. GAUDIN.

London, S.W.1, September 20th.

BOOKS RECEIVED.

The Running and Maintenance of Steam Reciprocating Machinery. London: The Institute of Marine Engineers, 85/88, The Minories, E.C.3. Price 5s. net.

Commercial Cinematography. By G. H. Sewell, F.A.C.I. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 7s. 6d. net.

The Law Relating to Electrical Energy in India. Fourth edition. By J. W. Meares, C.I.E. London: W. Thacker and Co., 2, Creed-lane, E.C.4. Price 24s. net.

Report on Steel Work for Buildings. Part 1, *Loads and Stresses.* London: The Institution of Structural Engineers, 10, Upper Belgrave-street, W.1. Price 1s. net.

Economic and Manufacturing Aspects of the Building Brick Industries. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 2s. net.

Principles of Electric Welding: Metallic Arc Process. By R. C. Stockton, A.I.M.M. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 7s. 6d. net.

Architectural Hygiene. Sixth edition. By Sir Banister Fletcher and Major H. Phillips Fletcher, D.S.O. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 10s. 6d. net.

The British Isles: A Geographic and Economic Survey. By L. Dudley Stamp, B.A., and S. H. Beaver, M.A. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 25s. net.

Compte Rendu Sténographique des Séances de la Quatrième Semaine Internationale du Machinisme a la Ferme. Lausanne: Institute International de Mecano-Culture, Campagne de "Mon-Repos."

The Iron and Steel Institute.

No. II.

(Concluded from page 291, September 22nd.)

On the resumption of the meetings on Thursday morning the first business was the presentation and discussion of the Fifth Report on the Heterogeneity of Steel Ingots.

The report as a whole was presented by Dr. W. H. Hatfield (Chairman of the Committee); and Principal C. A. Edwards and Professor J. H. Andrew presented briefly the results of the work described in Sections V. and VI. respectively, with which they had been particularly concerned. This report occupies nearly 80 pages of the printed "Proceedings" of the Institute, and cannot be usefully abstracted. We give, therefore, the official summary of its contents :—

HETEROGENEITY OF STEEL INGOTS.

The present Report is divided into the following sections :—

Section I.—Introduction.
Section II.—Ingot Types.
Section III.—The Present Position of the Analytical Determination of Non-Metallic Impurities in Steel.
Section IV.—A Further Study of Steel Ingots.
Section V.—A Study of the Influence of Varying Oxygen and Carbon Content in Iron upon the Position of Blow-holes in Steel Ingots.
Section VI.—The Equilibrium of the System Fe_2P-FeS.
Section VII.—Estimation of the Time of Separation of the Ingot from the Mould.

A certain amount of confusion exists concerning the precise meaning of the various terms descriptive of steel other than fully killed. In Section II., therefore, an attempt has been made to define the terms in common use. It will, of course, be understood that each ingot type merges imperceptibly into the next, and just as no hard and fast line differentiates the various ingots, so no hard and fast definition can be laid down to describe them. Nor do the Committee aim at establishing such definitions, rather is it their intention to clarify the position by discussing in some detail the various types of ingot, and the various terms commonly employed to describe them.

Section III. of the Report contains a discussion of the various methods employed for the separation and determination of the quantity and analysis of the silicate inclusions in steel, and for the determination of the oxygen. It has for a long time been realised that this matter has rested on a not too reliable basis, and now, whilst finality has been by no means reached, certain progress has been made towards improving the accuracy of the determinations.

In Section IV. is described the full examination of three further ingots. The first is a small ingot of high-frequency steel which, whilst possessing no outstanding features, shows the ingot examined to be of uniformly good quality. The second is an ingot of low-carbon steel made by the acid Bessemer process, and may be compared with Example 59, illustrated in the Fourth Report, which was made by the basic Bessemer process. Finally, the third is an example of ingot iron which, owing to its unique method of manufacture, possesses many interesting features.

Section V. is a contribution by two independent investigators, who, working in co-operation with the Committee, have explored on an experimental scale a wide range of compositions with varying oxygen and carbon contents. It is of interest, incidentally, tq notice how in Plate VI. each of the commercial types of ingot illustrated in Section II. is simulated in its general features, whilst this investigation also shows clearly the relation of one ingot type to another.

Section VI., also the result of work carried out by independent investigators, is an exploration of the iron phosphide/iron-sulphide equilibrium, and is of considerable interest in considering the theoretical aspect of the mechanism producing heterogeneity in steel ingots.

Finally, Section VII. further extends the mathematical analysis of the cooling of steel ingots to cover the mechanism of the separation of the ingot from the mould.

DISCUSSION.

Mr. E. H. Saniter (Vice-president) welcomed the report as one of the best, if not the best, yet issued, and one which presented a more complete picture than had been possible hitherto. In the course of a somewhat detailed commentary on the report, he referred to Section V., dealing with the effect of carbon and oxygen on ingot structure, as being exceedingly interesting, and said the authors, by proceeding on a definite predetermined plan, had succeeded in making a series of ingots representing all the ingots of commerce and some that were not commercial but were occasionally made. The authors had proved that in an oxidised steel the content of carbon had a predominating influence on the nature and position of the blow holes. It would have been of great interest to have had more information as to the formation of blow holes by nitrogen and hydrogen. He referred to one particular ingot containing no carbon, but which showed a small number of large blow holes, and asked if they might be due to hydrogen and/or nitrogen. Again, it would be valuable to know the composition of the gas in the inner and outer row of blow holes in rimming steel.

With regard to the existence of CO_2 in the evolved gases, he pointed out that that could only occur in small quantities, if at all, for CO_2 could only exist in contact with molten steel if accompanied by a very large excess of CO. As to the solubility of CO in steel, he asked if it were possible that CO was more soluble in steel the higher the oxide content.

Discussing the reasons why blow holes occurred in certain places, and why, in wild steels, some rose and others sank, he drew attention to the importance of turbulence and viscosity. In one particular ingot, for instance, the blow holes were very near the skin and the evolution of gas must therefore have been immediate; but lack of turbulence resulted in increased viscosity, and that prevented the free escape of the gas and caused the ingot to rise. In another case he suggested that the great turbulence accompanied by less viscosity resulted in the gas bubbles being washed from the sides so that the formation of a solid skin was allowed. The rapid evolution of gas and consequent great turbulence was the cause of the hollow top or "box hat," as that condition of rapid evolution of gas continued when teeming was finished.

Finally, he suggested that further work on the question as to why sulphur and manganese did not segregate in molecular proportions during the setting of steel ingots would be appreciated.

Dr. W. Rosenhain said the authors had pursued their immense task of trying to discover in detail the mechanism of the differences of composition of structure existing in all types of steel ingots, mainly by the "natural history" method, *i.e.*, by examining a number of specimens with great care. That was useful work, but it was pleasing to know that they had also made a very excellent beginning with the "synthetic" method of attack. The scientific way, and the only really sound way, of attacking a very complex problem of that kind was to isolate some of the variables affecting the problem. That could not be done in practical steel making, but it had been done very successfully, to a limited although very useful extent, in Section V. of the Report, which dealt with the influence of varying oxygen and carbon content in iron upon the position of blow holes in steel ingots. He welcomed that section particularly, not so much because of the immediate importance and interest of the results, which were considerable, but because it indicated a new step forward.

A criticism he made was that perhaps the Committee had begun their labours just a little late in the steel-making process, and that they might consider the heterogeneity of liquid steel before it was put into ingots. They should consider the possibility that the composition of the liquid steel was by no means uniform by the time it was poured into the ingot, particularly, he imagined, in large masses of steel in which the reactions had taken place between slag and metal bulk at the interface, and where the opportunities for thorough mixing of the liquid had not been very favourable.

Discussing the work on ingots made in the small high-frequency furnace, he pointed out that when one teemed a small quantity of steel there was an appreciable amount of reaction with the air through which the liquid steel passed; he believed that that reaction was quite appreciable, even in large ingots, and it must represent quite an important feature in very small ones. So that the size of ingot to be used in that work was a matter for careful consideration. On the small scale probably the work could be more accurately controlled, but there were countervailing disadvantages in the large ratio of surface to mass of metal, and it might be desirable to conduct further work on a larger scale, perhaps ten or twenty times the scale adopted so far.

After an expression of appreciation of the work on the sulphide and phosphide equilibrium, Dr. Rosenhain took exception to a statement that, although it was known that that was a ternary system, it was much simpler to represent it as a binary. The attempt to represent ternary and quaternary systems as binary systems was a form of simplification which was apt to be misleading.

Dr. A. McCance (member of Council) complimented Professor Edwards on having evolved a reliable technique in the production of small samples of steel; metallurgists were on the track of a system of experimenting which would give results representative of steel works practice. Commenting further on Section V. of the report, he referred to cases in which, where sufficient aluminium had been added to reduce the oxide sound steel was obtained. That represented a definite advance because it had been considered in the past that the gas in solution in steel had a marked effect on producing blow holes. He believed strongly that in all cases the gas formed was a reaction product, and that if one removed the iron oxide and the carbon or reduced them below the equilibrium balance, no blow-hole was formed, and that none of the blow-holes were due to the solution of gas in the metal. He suggested that the work should be extended in order to arrive in a practical manner at the equilibrium constant of the iron oxide reaction. He had in mind a method whereby standard ingots were prepared, definite quantities of oxide added in the neighbourhood of the equilibrium for the carbon content concerned, and then definite amounts of aluminium added to find out what amount of aluminium was necessary or what amount of oxide it was necessary to reduce in order to obtain sound steel.

Mr. H. Spence Thomas (member of Council) was interested to know that some value was being given to turbulence in the manufacture of steel and its effect in giving greater homogeneity to the ingot. He also emphasised the importance of considering the quality of the steel in the mass before it was separated into small ingots, and wondered whether by that means we might be able to eliminate entirely the troubles of segregation in ingots.

Dr. C. H. Desch referred to some work which was begun whilst he was at Sheffield University, and had since been continued at the National Physical Laboratory, as the result of which a perfected iodine method could be used to determine the quantity of inclusions absolutely without loss. The Dickenson method or the electrolytic methods used in America and Sweden led to a certain loss of ferrous oxide, because the water brought about hydrolysis of the more basic substances. By an improvement of the iodine method, however, excluding water entirely, using a solution of carefully dried iodine in absolute alcohol, working in a nitrogen atmosphere, and filtering entirely in nitrogen through an ultra filter, it was possible to recover the whole of the inclusions without loss. They could be examined under the microscope and a subsequent analysis made. That was not likely to become available as a general works process, however, because it was rather too sensitive. Even breathing anywhere near the opening of the apparatus before it was closed would affect it, for the amount of moisture required to produce hydrolysis was extraordinarily minute. For organisations equipped with research laboratories, however, he believed it was likely to be the best of all methods. There was a plan in view for the co-operative comparisons of the different methods of oxygen determination in certain known steels, and before long practical methods of oxygen determination would be applied in any well-equipped steel laboratory.

Mr. N. D. Chopra suggested that homogeneity could be improved by the tilting of moulds and agitation of the molten metal. The three main causes of trouble in steel ingots, which causes it was desired to eliminate, were (1) the pipe or cavity; (2) occluded gases or blow-holes; (3) the crystalline condition. He submitted that all could be eliminated by mechanical methods, *i.e.*, by turbulence or agitation of the molten metal. Steel metallurgists had something to learn from non-ferrous metallurgy. In a works in south-east Germany it was found that by tilting the mould at 8 deg. the tensile strength of the steel produced was increased by 22 per cent. on the average; the elongation and reduction of area by over 40 per cent.; and the impact figure was more than three times that of steel which was cast under the same conditions but by the ordinary horizontal method.

Dr. Hatfield, in reply to the discussion, said that anyone who studied the report would be surprised to find how nearly the Committee had arrived, by the guidance of the evidence contained in the report, at almost technical perfection. It was true to say that solid ingots for forgings, as made in Sheffield and Glasgow, were remarkably good from the standpoint of a technical analysis of the degree of heterogeneity. But the problem was involved because in the heavy steel trade it was important to use the maximum proportion of ingots in the finished products. Thus there were two problems in one, for any solution involving a high scrap percentage in production would not be tolerated.

The Committee had indeed studied a perfect ingot. It was produced by pouring the steel in the mould at a temperature at which it froze almost spontaneously, and it weighed about 14 cwt. That could be done, he would not say "accidentally," but as a stunt. When producing a very large ingot, however, one could not pour at one particular temperature, but must cast over a range of temperature.

He gathered that Dr. Rosenhain had not deprecated the "natural history" method of investigation, which was the basis of all research. Anyone who was disclosing the facts of nature was essentially following the natural history method, and he considered that the Committee was right in basing its work largely on determining very thoroughly and completely the degree of heterogeneity of the various types of ingots now produced. Then they had built up from that.

"The Influence of Beryllium on Steel," by Mr. J. H. S. Dickenson and Dr. W. H. Hatfield, was the title of the next paper presented. We give the conclusions reached by the authors.

BERYLLIUM IN STEEL.

The results disclosed by this investigation indicate little or no prospect of the element beryllium becoming a useful addition to the group of metals used in the manufacture of special steels. The metal is extremely expensive, and is unlikely ever to become reasonably cheap, whilst its lightness and readiness to oxidise make the actual introduction into molten steel somewhat difficult and distinctly wasteful, even with the special method of addition employed in the present case.

As regards forging, the addition of 1 per cent. of beryllium tended to make some of the steels, particularly the 3½ per cent. nickel and the nickel-chromium steels, distinctly "stiffer" under the hammer, with an increased tendency to "burst," especially towards the top end, but it is probable that this would give rise to no serious manufacturing difficulty if the beryllium steels were required for use in engineering construction because of their desirable physical properties.

In this respect, however, the addition of beryllium has proved harmful rather than otherwise.

Apart from the hardness peak in the tempering range 400 deg. to 450 deg. Cent. and the associated brittleness and the liability to crack with rapid cooling, probably due to some pronounced volume change, the beryllium-bearing steels show throughout a marked liability to fragility, as evidenced by the impact test, which far outweighs the increase in tensile strength. In short, none of the steels containing beryllium has shown, with any treatment, the combination of high elastic limit and fatigue resistance with ductility and toughness, which is necessary in highly stressed engine parts. It was thought that the addition of beryllium might confer upon stainless steels of the 18 per cent. chromium, 8 per cent. nickel type, which are normally austenitic, an increased resistance to corrosion, but in this case also the results were definitely disadvantageous.

In conclusion, the authors would again repeat that this investigation was carried out with a limited objective, and neither time nor circumstances have so far permitted an extension of the programme, but they consider that certain of the facts disclosed, especially the temper-hardening at 500 deg. Cent., deserve much further investigation, and it is for this reason that they are presenting this paper.

DISCUSSION.

Dr. A. McCance, after remarking that the work described in the paper provided a good example of co-operation between firms engaged in the same line of business and two large research organisations, and that that example might, with advantage, be followed by other sections of the steel industry, thanked the authors for having overcome the difficulty of introducing beryllium into steel. He deprecated haste in forming an opinion as to whether or not beryllium had any future. Its price had been reduced as the commercial demand had increased, and there was no reason to think that it could not be carried lower if there was a larger demand. The actual physical properties of the steel in which it was used, however, did not look very promising. But beryllium, like all the lighter elements, depressed the change points very rapidly, with the result that the γ loop was closed with a very small percentage, something in the nature of 0·5 per cent. beryllium. With 1 per cent., therefore, it was outside that loop, and in a field where refinement of the grain structure could not take place by heat treatment alone. Brittleness in the 70 per cent. chromium irons had been overcome, and those alloys were obtained in a perfectly tough and useful form. Similarly, with beryllium, given a little further experience in the technique and manipulation, it might be possible to overcome the intense brittleness which it seemed to confer on steel. The important property was age-hardening, but he believed similar age-hardening properties could be obtained by the use of other elements at much less cost, although it would be interesting to study the effect of beryllium on high-speed steel, for the age-hardening range came within the tempering range of that steel, and it might increase the property of age hardness. So that while the results of the work were negative, so far as immediate application was concerned, the paper would be an important record for future investigators.

Dr. W. Rosenhain said he had several experimental melts of beryllium-iron alloys which showed remarkable properties, and he supported the warning uttered by Dr. McCance that the research should not be regarded as a final condemnation of beryllium as a possible element in connection with steel. The remarkable function which beryllium performed in nickel and copper was well known. The age-hardening effect of beryllium in copper, he believed, was greater than that of any other element in any other metal known, and in nickel it was of about the same order. Therefore, one might hope that if beryllium was rightly used, if the proper technique of heat treatment, and so on, was applied, it might be possible to obtain age-hardening effects in steel of a very marked character, taking into account that steel was initially harder and stronger than copper. Further investigation, on perhaps rather different lines from those indicated in the paper, would have to be made before the question as to the value of beryllium in steel could be determined.

Dr. Hatfield intimated that the 6 lb. of beryllium available to the authors for their experiments had cost £200, *i.e.*, over £30 per lb. So that he was afraid much time must elapse before the matter could become of great interest from the economic point of view.

Mr, Dickenson, replying to the discussion, said he was certain that neither Dr. McCance nor Dr. Rosenhain had supposed for a moment that the authors had left no loophole open for the future use of beryllium. The point was that the authors had concluded from their experiments that at the present time, under prevailing circumstances, there was no hope of getting a useful result with it which would approach justification of the expenditure involved. It was true that aluminium, at one time a museum specimen, now surrounded us in every direction, in quantity; but that hardly applied to any ore from which beryllium could be extracted. In short, he could not see at present any prospect of cheap beryllium.

The meeting then discussed a report by Dr. Marie Gayler on the "Alloys of Iron Research: Part XI., The Constitution of the Alloys of Iron and Manganese," of which a summary follows.

ALLOYS OF IRON AND MANGANESE.*

The constitution of the iron-manganese alloys has been determined by means of thermal, microscopical and X-ray examinations of alloys made from high-purity electrolytic iron and distilled manganese. In comparison with previous determinations, the position of the liquidus and solidus has been appreciably raised and the existence of a peritectic reaction between γ-iron and liquid to form γ-manganese has been confirmed.

The δ–γ iron transformation has been found to take place at 1504 deg. Cent. over a range of composition of 1 to 8 per cent. of manganese; γ-iron then separates directly from the liquid state, until at a temperature of 1270 deg. Cent. it reacts with the manganese-rich liquid to form a phase containing approximately 68 per cent. of γ-manganese. This peritectic reaction extends from 65 to 74 per cent. of manganese, after which the γ-manganese phase separates directly from the liquid on cooling.

The constitution in the solid state of iron-rich alloys has not yet been solved and has, therefore, not been included in the constitutional diagram submitted.

The changes in the solid state of manganese-rich alloys have been very carefully determined by means of the thermal, microscopical and X-ray analysis of a number of alloys. The γ-manganese phase is shown to decompose into γ-iron and β-manganese at a temperature of 1028 deg. Cent. over a range of composition of 64 to 72 per cent. of manganese, and similarly the β-manganese phase has been shown to decompose into γ-iron and α-manganese at 600 deg. Cent. over a range of composition of about 59 to 63 per cent. of manganese.

An Appendix by C. Wainwright, M.Sc., on the X-ray structure of manganese-rich alloys quenched from various temperatures is given.

DISCUSSION.

Dr. W. Rosenhain commented on the immense difficulty of the work described in the paper, and the endless patience with which those difficulties had been overcome; during many years' experience of research on alloys he had never known difficulties approaching those encountered in that particular work. Having emphasised the difficulty of the work, he continued, one might ask why it was done. For the benefit of those who were not enthusiasts he pointed out that there was a very good reason—that we should never understand our alloy steels thoroughly and gain full command of them until we understood their constitution and the changes occurring at different temperatures. So far we did not understand them sufficiently thoroughly. Many steel makers were in the habit of regarding alloy steels as iron-carbon alloys with something added; that, however, was not so. Current views on many of those alloys were at any rate imperfect and very misleading, and as the demands upon our special alloy steels increased in severity, the demand for accurate knowledge and the spade work which produced it, of which the paper provided a striking example, would increase. We must know the constitution of those alloys in the pure state before we could claim a knowledge of the ternary and quaternary systems; in many cases, contaminations influenced very definitely the resultant structure and constitutional change.

Dr. C. H. Desch, after confirming Dr. Rosenhain's remarks concerning the very great experimental difficulties and the great skill with which they had been overcome, said the iron side of the diagram had been held over at pressent because the data were not sufficiently complete; but that part of the diagram was exceptionally difficult, partly because there arose the same kind of difficulty that occurred in the iron-nickel series, *i.e.*, that of irreversibility; it was almost impossible to attain equilibrium. In that work one had to depend to a very large extent on X-ray data, because the multiple twinning was so elaborate that it was difficult to determine by microscope whether there were one or two phases. However, the work was being continued, for in order to gain knowledge of the alloy steels, metallurgists needed a knowledge of the fundamental binary diagrams.

A description of "A Coke-fired Re-heating Furnace" by Mr. F. Lloyd and Prof. R. V. Wheeler was then presented by Mr. F. Lloyd, who said that the coke-fired furnace described was an employers' contribution to the problem of smoke abatement.

A paper by Mr. J. E. Hurst on "Some Experiments on the Resistance to Heat of Nitrogen-hardened Cast Iron" was taken as read. There was no time for its discussion. It will be reprinted in a future issue.

The Institute of Metals.

IT was natural that the Institute of Metals should return to Birmingham, its birthplace, for its silver jubilee meeting, which was held last week under the presidency of Sir Henry Fowler. It was in 1908 that its first general meeting was held there, under the presidency of the late Sir William H. White, and the meeting this year was held in the same room, at the Central Technical College.

Again, it was natural and proper that on such an occasion some attention should be given to surveying the progress that has been made since the Institution's inception. Thus, the autumn lecture, which was delivered this year by Mr. W. R. Barclay, O.B.E. (a Vice-President of the Institute, and consulting chemist to the Mond Nickel Company, Ltd., of London), surveyed twenty-five years' progress in metallurgical plant in a masterly and interesting manner, and very many illustrations were shown of plants both in this country and abroad. A report of this lecture is printed on page 312. Another contribution on somewhat similar lines was an address by Dr. W. Rosenhain, on some steps in metallurgical progress between 1908 and 1933.

Invitations to visit a number of works were extended to and accepted by the Institute. The works visited included those of Earl, Bourne and Co., Ltd. (rolling and tube mills), the Austin Motor Company, Ltd., the General Electric Company, Ltd., I.C.I. Metals, Ltd., the London Aluminium Company, Ltd., W. and T. Avery, Ltd. (Soho Foundry), Joseph Lucas, Ltd. (lamps and accessories), Henry Wiggin and Co., Ltd. (nickel and its alloys), and the Birmingham Aluminium Company, Ltd.

From the social point of view the meeting was also memorable, including, as it did, municipal and university receptions, a luncheon, and visits to places of interest in the Midlands. The joint hosts at a luncheon on Tuesday, September 19th, were the Aluminium Hollow-ware Association, the Brass and Copper Tube Association, the Brazed Brass Tube Association, the Brass Wire Association, the Cased Tube Association, the Cold Rolled Brass and Copper Association, the Manufactured Copper Association, and the Nickel Silver Association.

A novel feature during the meeting was the reproduction of the first office of the Institute, in the Metallurgical Department of the University. This office was set up originally by Mr. Shaw Scott, who, together with the President and the Chairman of the Executive Committee, received there on Tuesday evening the surviving original members. This reception was quite informal, and the visitors had the opportunity of inspecting the earliest records of the Institute, including the original membership applications, and some photographs taken during the inaugural meeting in 1908. At that time the membership numbered about 200; it has now increased to 2200, and covers the whole world.

It was announced by the President during the course of the meeting that, although the Institute has not been affected from the points of view of membership and finance as much as some other bodies during the depression, a number of the original members had contributed to a special fund to promote the further progress of the Institute. It was proposed to use the money particularly in connection with publications. It had come to the knowledge of the Council, said the President, that certain members and firms in addition to the original members would like to contribute, and he intimated that the Council would welcome such contributions.

Dr. Barclay's lecture was the first official function of the meeting, and he delivered it on Monday evening, September 18th, in the Medical Lecture Theatre at the University of Birmingham, to an audience which almost taxed the quite considerable seating capacity of the theatre.

On Tuesday morning, after a civic welcome, Dr. Rosenhain presented his paper entitled "Some Steps in Metallurgical Progress, 1908–1933."

TWENTY-FIVE YEARS OF PROGRESS.

In presenting this paper Dr. Rosenhain said that the last twenty-five years had seen the battle for the recognition of scientific metallurgy fought and, he believed, won. Anyone who talked scientific metallurgy twenty-five years ago was looked upon as an academic enthusiast who was likely to have very little effect on metallurgical practice. There might be some who still thought in that way, but they were very few, and dare not raise their voices in public. Often he had heard young men regret that they had not lived thirty or fifty years ago, because then there was so much to be discovered, whereas now it was hard to find anything new because of the immense amount of work done already. He, too, had felt like that at one time—and every man who saturated himself with the knowledge already acquired was apt to think that it would have been easier to make advances if he had lived before it was discovered. But the facility for making fresh discoveries lay in the man much more than in the knowledge existing at the period in which he worked; and, indeed, if he appreciated rightly the knowledge already available it should give him openings more numerous and more readily available for attack to-day than ever before.

The paper was not submitted for discussion, inasmuch as it was in the nature of an address.

Two papers summarised below were then submitted together for discussion. They were "Properties of Some Temper-hardening Copper Alloys Containing Additions of Nickel and Aluminium," by Messrs. Brownsdon, Cook, and Miller, and "Precipitation-hardening Nickel-copper Alloys Containing Aluminium," by Messrs. Jones, Pfeil, and Griffiths.

TEMPER-HARDENING COPPER ALLOYS.

A study has been made of the effect of quenching and tempering on the properties of a number of copper alloys containing nickel and aluminium, and it has been found that when nickel, together with aluminium, are present in certain quantities and ratios, the hardness and other mechanical properties of the alloys are very considerably modified by the thermal treatment to which they are submitted. The alloys are softened by quenching from relatively high temperatures, and the quenched alloys, both in the soft and cold-worked conditions, harden considerably when re-heated or tempered to an intermediate temperature somewhat below the annealing temperature. For a few typical alloys the changes in hardness and mechanical properties that can be brought about by suitable heat treatment are given in some detail.

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* Communication from the National Physical Laboratory, received June 7th, 1933.

NICKEL-COPPER ALLOYS.

The properties of nickel-copper-aluminium alloys with nickel contents from 10 to 45 per cent. and aluminium contents up to 4 per cent. have been investigated.

The relationships between composition and capacity for hardening by heat treatment have been studied by means of hardness tests on the heat-treated specimens. A study has also been made of the most suitable heat treatments to produce the soft condition, and the stability at elevated temperatures of a selection of the alloys in the precipitation-hardened condition. Finally, the mechanical properties have been determined of a group of alloys selected and prepared in accordance with the results of the preliminary experiments.

In certain cases the properties of the 20 per cent. nickel alloys were studied in greater detail than those at other nickel levels, but sufficient work has been carried out on alloys containing 10, 30, and 45 per cent. nickel to enable the properties of alloys at these levels and over a range of aluminium contents, and in various conditions of heat treatment, to be deduced.

DISCUSSION.

Mr. W. T. Griffiths, in presenting the second paper, took the opportunity to emphasise the difficulties with regard to nomenclature, as illustrated by the papers so far presented. In the first, Dr. Rosenhain had referred to " age-hardening " and " precipitation-hardening " ; in the second, reference was made to " temper-hardening " ; and in the third, " precipitation-hardening " was referred to. The time had arrived, therefore, to determine exactly how to describe this phenomenon, and the difficulty was to find words to describe the actual treatment. He and his co-authors had at first used the word " temper " when referring to the re-heating process. It was necessary, however, to describe that operation so that it would not be confused with the tempering treatment in steel, for some were in the habit of regarding that tempering as a softening rather than a hardening process. He suggested, therefore, that the Institute might be asked to give a ruling on the matter.

Professor D. Hanson (Vice-President) said the earlier heat-treated copper alloys mostly possessed rather low elastic limits—perhaps the beryllium alloy was an exception—but the particular alloys dealt with in the papers could be obtained, by simple heat treatment, in a condition in which they attained very considerable elastic limit ; that was a notable advance. That elastic limit might be still further improved by the application of a small amount of cold work, followed by still further heating, or perhaps by cold work before the tempering or re-heating process.

The authors gave a host of facts which it was difficult to correlate ; it was clear that they were rather groping in the dark, and he could not help feeling that it would be wrong to allow work of this kind to go too far without trying to find out just the constituents responsible for the phenomena produced, and what were the changes in solubility and so on which governed the heat treatment. He suggested that more attention could be paid to the properties—particularly the physical properties—produced in these alloys by varying the periods of tempering.

Dr. E. Vaders (Germany), discussing the paper by Messrs. Brownsdon, Cook, and Miller, said the authors' statement that the maximum aluminium content permissible in nickel-copper alloys was about 3 per cent. did not appear to be right in all cases. He had found that aluminium-nickel-copper alloys could easily be cold-rolled if, in the presence of 3 per cent. of aluminium, the nickel content was not more than 15–20 per cent. If the aluminium content rose to 4, 5, or even 6 per cent., the nickel content must be reduced to 10 per cent. or less. Aluminium-nickel-copper alloys containing about 10 per cent. nickel, 5 per cent. aluminium, and 85 per cent. copper, had a Brinell hardness of 70 when quenched. They could be rolled both in the cold and in the hot condition without difficulty.

He had found also that an addition of iron to aluminium-nickel-copper alloys might be useful, investigations having been carried out with iron contents from 5 to 15 per cent. It was found, for instance, that an alloy containing 10 per cent. nickel, 5 per cent. aluminium, and 85 per cent. copper showed marked temper-hardening effects if 10 per cent. iron were added, whereas the alloy free from iron possessed no hardening tendencies.

The solubility of aluminium in nickel-copper alloys seemed advantageously influenced by the iron. When quenching alloys containing iron, more aluminium was held in solid solution than with alloys free from iron. In consequence, the mechanical properties of those alloys were much higher than of the ternary aluminium-nickel-copper alloys. Certain iron-aluminium-nickel-copper alloys had a tensile strength of about 77 tons per square inch, and elongation of 3–4 per cent. The alloys were not badly influenced by the iron in respect of rolling properties. He had cold-rolled an alloy with 10 per cent. iron from 6 mm. to 0·5 mm. thick without annealing. The elongation of that alloy in the soft, *i.e.*, the quenched, condition was about 50 per cent., and in other alloys it was more than 60 per cent.

From the results obtained it appeared that the nickel content and the aluminium content were dependent on each other, inasmuch as a low nickel content entailed a high aluminium content, whereas, on the other hand, a high nickel content entailed a lower addition of aluminium.

With regard to a statement in the paper by Messrs. Jones, Pfeil, and Griffiths, that with increasing aluminium content a higher temperature was necessary to give the best precipitation-hardening, he said that was only the case in respect of alloys free from iron and having low nickel content. The aluminium-nickel-copper alloys containing iron were of interest not only for their high tensile strength, but also their magnetic properties and good resistance to heat. An addition of only 5–10 per cent. iron was sufficient to render the alloys strongly magnetic. The permeability, &c., had not yet been investigated. It might be that those properties would render the alloys useful for electrical purposes, the more so as they were absolutely rustproof. With regard to heat resistance, certain alloys in that range were not seriously attacked, even if heated to 900 deg. Cent. for three hours ; they remained bright and smooth.

Mr. A. L. Archbutt (Member of Council), Mr. E. H. Bucknall, Mr. W. F. S. Hubbard, and Mr. A. J. Murphy also spoke.

Dr. Cook, replying to Professor Hanson, said the authors realised that the experiments on the improvement of the elastic limit by a combination of heat treatment and cold working were only preliminary, and they felt that the work could usefully be extended in that direction ; they were optimistic about obtaining even better values than those recorded in their paper.

With regard to the effect of time and temperature, he said the experiments were not directed entirely to finding out the minimum time in which to accomplish the maximum hardening. It might be—though there was no evidence from the results to suggest it—that a longer ageing period at lower temperatures would give better information on the qualities generally.

To Dr. Vaders he pointed out that, as stated in the paper, when the aluminium content exceeded about 3 per cent., they had experienced difficulties in cold fabrication of the alloys. They knew that for hot work the aluminium content could be raised to 5 per cent. or so. In that connection he drew attention to a statement in the other paper that, in the preparation of the alloys, ingots which were ¾in. thick after softening by quenching were cold-rolled to ¼in.—a reduction of 66 per cent. In view of his experience, however, he suggested that that was extraordinarily difficult to accomplish, especially in alloys with an aluminium content exceeding, say, 4 per cent. Some of the tables showed that those alloys, even in the quenched, *i.e.*, the softest possible condition, had a Brinell hardness in excess of 200.

Mr. Griffiths, replying on behalf of Mr. Jones, Mr. Pfeil and himself, said that while they had been able to give a certain amount of information on the alloys studied, they had still much to learn, especially in regard to the reasons why. They had ideas, but not definite proof. The fact was that the problem opened out by work such as that was enormous. Small amounts of constituents which they had not yet considered might affect the results considerably. Their purpose was to place on record some of the results obtained during the past five or six years, to stimulate other workers. The task of finding the reasons why might be considered perhaps by the academic and university laboratories.

In reply to Dr. Cook, he said that he and his collaborators had not attempted cold-rolling the alloys with high aluminium content, but had hot-rolled them.

A paper on " Wear in the Polishing of Plated and Other Surfaces," by Dr. O. F. Hudson, was then presented.

POLISHING OF PLATED SURFACES.

A series of tests was made in the laboratory of the British Non-Ferrous Metals Research Association to determine the comparative rates of wear of plates and other metal specimens under conditions of polishing as distinct from abrasion. The apparatus used is described, and the results obtained with the following materials are given, using magnesia on wet parchment as the polishing medium :—Pure platinum, pure palladium, platinum plating on brass, palladium plating (" soft," " hard," and burnished) on brass, nickel plating (" soft " and " hard ") on brass, silver plating, and brass (60 : 40).

Considered as loss of thickness, the rate of wear of the palladium-plated specimens was found to be greater than that of the platinum-plated specimens, but considered as loss of weight, the wear of the palladium coatings was slightly less than that of the platinum coatings ; whilst the precious metal coatings generally were more resistant than the same metals in massive form. Of the three types of palladium-plating, that in the " soft " condition showed the greatest wear, but the differences were not great ; there was little difference in the rates of wear of the two kinds of nickel-plating. No definite or consistent relationship between hardness and rate of wear in polishing was revealed in these tests.

DISCUSSION.

Dr. W. Rosenhain (Past-President) said he was particularly interested in the author's use of magnesia as a polishing agent, for he himself had introduced it for metallographic purposes about 1904, and its use had been adopted widely since. He had first used it because he had been anxious to obtain polished surfaces of specimens consisting of two metals—iron and copper—in juxtaposition, and the difficulty was that the ordinary polishing reagents, such as rouge and chromium oxide, dragged one metal over the other to such an extent that the boundary line between the two was difficult to trace. Magnesia dragged less than any other polishing material, and his suggested explanation for its behaviour was that it was not a true polishing agent, but was a very fine-grained abrasive. Polishing was connected with the solubility of the polishing agent in the metal that was polished, and he imagined that magnesia had very little of that property. Possibly the ratio of wear obtained by Dr. Hudson would be rather different if rouge were used instead of magnesia. Again, abrasion was partly a chemical action, and oxidation played a very considerable part. Therefore, when comparing metals such as platinum, on the one hand, and nickel or even silver, on the other hand, one was not comparing them under identical conditions, unless one excluded the action of oxygen. Possibly, the failure to discriminate between hard and soft nickel was due to their being chemically attacked at very much the same rate. One could not eliminate abrasion from polishing experiments, and, if there were no abrasion, he could not see how there could be loss of weight.

Mr. H. N. Bassett (Chief Chemist, Egyptian State Railways), also said he could not understand how there could have been loss of weight without abrasion. He suggested that there was a very fruitful field in the investigation of the preparation of polished surfaces with different abrasives under precisely similar conditions, particularly in different atmospheres.

Dr. Hudson, in his reply, said the paper was simply a record of some experiments with one particular polishing material. It was probably correct that abrasion of a sort did occur ; but there was a distinction between a process such as the final polishing and the abrasion arising in the use of a coarse abrasive as a preliminary operation before final polishing.

The meeting then adjourned until Wednesday.

When the meeting was resumed on Wednesday, September 20th, the first paper to be taken was one entitled " Further Observations on the Distribution of Porosity in Aluminium and Copper Ingots, with Some Notes on Inverse Segregation," and the author was Mr. N. P. Allen.

ALUMINIUM AND COPPER INGOTS.

The author reports that three copper ingots and four aluminium alloy ingots cast in a specially tapered mould were examined. In all cases the distribution of porosity followed the probable form of the isotherms in the cooling mass, and was much influenced by the mould taper. The type of microstructure also had an influence on the distribution of porosity, the nature of which he discusses. The inverse segregation of two aluminium-copper alloy ingots was found to be closely related to their porosity.

DISCUSSION.

Mr. H. Sutton said that at the Royal Aircraft Establishment, Farnborough, large aluminium alloy ingots for forgings were cast with a hot-top or dozzle lined with sand, which resulted in good feeding, and appeared generally beneficial. Inverse segregation could not be avoided in that way, however. Bohner had found that " topping-up " ingots during freezing had no important effect from a practical point of view on inverse segregation, but his results on aluminium alloys indicated that both inverse and normal forms of segregation could be minimised by the use of very high or very low rates of cooling of the molten alloys. That indication was in good agreement with the view that inverse segregation was the result of volume changes.

Mr. R. Genders, whilst agreeing substantially with Mr. Allen's conclusions, pointed out that certain variables of the casting process had been neglected altogether, so that some of the generalisations made in the paper were subject to modification. He discussed the theory of inverse segregation. Commenting on a copper mould illustrated in the paper, where the thickness of the wall at the bottom was increased substantially in order to encourage progressive solidification from the bottom upwards, he said that although those conditions might encourage it, the encouragement was never sufficient to have any appreciable effect.

Dr. W. Rosenhain remarked that unfortunately the facts quoted did not tally with the facts found frequently in the production of ingots of various sizes under other conditions. He was unable to understand how the author had arrived at some of his conclusions, and it was difficult to reconcile the view as to the outward flow of rich inter-dendritic liquid with the suggested existence of negative pressure inside the ingot. He doubted very much that a negative pressure ever existed, except very transitorally. He had seen many examples in which there was no doubt that the method of filling the mould had made a great difference.

Dr. F. Johnson welcomed a reference in the paper to an ingot of copper which had shown a considerable rise in the mould after being melted in a highly reducing atmosphere ; that result disposed of the argument that electrolytic copper could not be over-poled. Discussing inverse segregation, he referred to an instance within his own experience concerning a very small ingot of Admiralty gun-metal with low tin content in the outer shell and high tin content in the interior, there being almost complete absence of the low melting point interdendritic constituent in the outer shell and a preponderance of it in the centre. That was a very clear case of inverse segregation, but was not in line with Mr. Allen's explanation of the internal pressure forcing a low melting point constituent into the interdendritic spaces.

Dr. A. G. C. Gwyer called Mr. Allen's attention to the recent work of Masing and Scheuer, who regarded inverse segregation as being due not so much to contraction processes as to the growth of the primary crystals forcing the nuclei apart and intersticial flow occurring in the spaces.

Mr. Allen, replying to the discussion, said he did not think there was really much doubt that exudations on the surface of a casting must be caused by gas. In a comment on Dr. Rosenhain's remarks concerning the pressure inside the ingot, he suggested that Dr. Rosenhain had neglected the possibility that there might be variations of pressure in the liquid metal from side to centre of the ingot.

A "Note on the Green Patina on Copper: Examples from Elan Valley (Wales) and Dundalk (Ireland)," by Dr. W. H. J. Vernon, was then presented and discussed.

It was followed by one on "Magnesium Alloy Protection by Selenium and Other Coating Processes," by Dr. Bengough and Mr. Whitby. They observe that small losses of weight of Elektron alloy AZM (sheet) resulting from corrosion by immersion in or spraying with sea water have been found to be associated with serious losses of elongation. Visual inspection did not suggest the extent of the damage, which occurred even when the alloy was protected by chemical coatings and paint.

The last paper read and discussed was entitled "Experiments in Wire Drawing: Part III.—Annealing of H.C. Copper Wires Drawn to Varying Degrees of Hardness," and was by W. E. Alkins and W. Cartwright. The authors' summary runs as follows :—

EXPERIMENTS IN WIRE DRAWING.

Silver-free h.c. copper of good quality (99·95 per cent. copper) was drawn into nominal No. 12 S.W.G. (0·104in.) wire, intermediate annealing being introduced in such a way as to furnish eleven coils of wire varying in breaking load from 399 lb. to 544 lb., and with reductions of area after annealing of from 36 to 97 per cent. Samples were annealed for periods of one-half, 1, 2, 6, 12, and 24 hours, at 130 deg., 155 deg., 170 deg., 180 deg., 205 deg., 230 deg., and 280 deg. Cent., and for half an hour at 330 deg. 450 deg., 650 deg., 750 deg., and 850 deg. Cent. Mean breaking loads after each heat treatment, frequently and carefully checked, are published.

It is found that the annealing behaviour depends not so much on the original tensile strength of the wire as on the amount of reduction by cold work which it has undergone. To express this in a form convenient for diagrammatic representation, the "work ratio"—diameter at intermediate annealing divided by final diameter—is used.

The more lightly drawn wires show an appreciable increase in strength after annealing at low temperatures. They retain their strength at temperatures up to, say, 250 deg. Cent., very much better than the harder wires. The latter begin to soften at temperatures little above 100 deg. Cent., and the rate at which strength is lost increases with increasing cold work. The hardest wires all show a definite decrease in breaking load after storage for two years at room temperature; the more lightly drawn wires show no change. This apparent differentiation is again suggested by the breaking load/temperature curves from 450 deg. to 850 deg. Cent.: the lightly drawn wires decrease slightly but steadily in strength with rising temperature, but all the harder wires without exception have higher breaking loads after annealing at 750 deg. Cent. and again at 850 deg. Cent. than they have after heating at 650 deg. Cent.

After all heat treatments of sufficient severity to effect more or less "complete" annealing, the breaking load is lower the less the amount of cold work done on the wire, and it increases steadily with increasing cold drawing until the three most severely drawn wires of all are reached, when there are fairly definite indications of a decrease in the strength of the fully annealed wire.

The importance of these facts from the point of view of any theoretical discussion of annealing phenomena, and conversely in their bearing on the whole problem of hardening by cold work, is evident.

DISCUSSION.

Mr. E. H. Bucknall, after a brief reference to earlier work, including some carried out by the Non-Ferrous Metals Research Association on locomotive stay rods, in which marked stiffening of cold-worked materials was effected in low-temperature annealing, said it would appear that with hard-drawn wires there was at the higher temperatures a hardening, possibly of the same type as that of the lightly drawn materials at the low temperatures. He also suggested that it would be enlightening to investigate the effect of annealing for periods shorter than half an hour at elevated temperatures, as well as the effect of annealing for longer periods at lower temperatures.

Professor D. Hanson (Vice-president) suggested that the authors might enhance the value of the paper by attempting some estimate of the crystal size in their wires, for it might provide a complete explanation of their results. They had summarised their results in the statement that "the greater the amount of cold work done on the material, the lower is the temperature at which it begins to lose its work hardness and the greater the rate of loss at any temperature, but the higher is the tensile strength characteristic of the fully annealed material."

Dr. H. O'Neill asked if the authors could give the values for reduction of area for tensile test pieces. Discussing the method of preparing the copper, he said it was first cold drawn to decreasing diameters, then annealed, and finally cold drawn. He gathered that the annealing, at 650 deg. Cent., of copper which had been reduced various amounts meant that the breaking load would differ in the different specimens, so that the specimens were not necessarily in the same condition when cold drawing was begun. What would be the objection to hot working the original bolt down to the various sizes, then annealing to remove working strains, and then finally cold drawing?

Discussing a reference to increased breaking load and decreased ductility, he mentioned some X-ray examinations of cold-rolled copper annealed at 130 deg. Cent. to produce slight stiffening. The copper was cold rolled about 50 per cent., and showed distinct preferred orientation. After heating at 130 deg. Cent., the only change detected in the X-ray spectra was a slight decrease in the intensity of the preferred orientation. If that were substantiated it would suggest that the grain size was more "messed up," and he suspected that perhaps within the distorted grains tiny new grains were forming, and that there was a mist of these new grains throughout the mass, which meant more boundary and greater stiffness or decreased ductility. This might be the reason for the rise of breaking load reported by the authors.

Dr. H. W. Brownsdon disagreed with a statement in the paper that, in the light of the results obtained, the tensile strength of a "completely" annealed high-conductivity copper wire was emphatically not a characteristic property of the material. Copper, he said, was a most subtle material, and minute quantities of impurities seriously affected the mechanical and other properties, and he did not think the authors' work justified the use of the word "emphatically." With regard to their statement that they had used a "silver-free" high-conductivity wire, he believed there was only one brand which satisfied that designation; the majority of high-conductivity coppers within his experience contained silver, and he suggested that the authors' results should be clearly related to the one sample they had used as a special sample.

Mr. J. S. G. Primrose, referring to the increase of breaking load—which really meant the maximum and not the theoretical breaking load—said he had found that low-temperature annealing released the stress in the skin of lightly drawn copper and other wires, which stress was due to the light drawing, and had not penetrated to the centre. Thus the true stress on the material was recorded in the breaking load.

Mr. H. J. Miller commented upon the slight increase in strengths which the authors had obtained by annealing at very high temperatures, and the different range of results obtained, depending on the previous amount of cold work. It was notable that in one table of results the wires subjected to the least amount of cold work showed continued softening as the annealing temperature was raised, whereas those subjected to a greater amount of cold work showed definite increase of strength with the highest annealing temperatures. He suggested that these results were associated with the development of directional properties consequent upon differential grain growth, since the factors involved—excessive cold work and a high annealing temperature—were known to be responsible for the development of directional properties. Unfortunately, wires could only be tested in one direction; it would have been better if the authors had worked on strip.

Mr. Cartwright, replying to the discussion, said the authors had attempted to tackle the problem of crystal size, but the greatest difficulty was that they could not use for wires the usual method of counting crystals. In reply to Mr. O'Neill, he said that they had no figures for reduction of areas, but hoped to publish a short note in the near future giving elongations. As to the preparation of the specimens, the trouble was that they could not hope to hot-roll down to the small sizes used. In reply to Dr. Brownsdon, he said the analyses made by the authors were not spectroscopic, but were made by the ordinary analytical method, and, judging by that method, the material was silver-free. They were glad to obtain so pure a copper, because they desired to investigate pure copper first, so that later they could make additions to it, and would know that the difference in the results obtained would be due to the additions. Finally, he assured Mr. Miller that they would take the earliest opportunity to study directional properties.

SIXTY YEARS AGO.

THE decay of the British Association was the somewhat startling subject with which we dealt in a leading article in our issue of October 3rd, 1873. The Association had been founded about forty years previously, at a meeting held at York. A body of quiet, unobtrusive men of science and research had formed it with the object of making up the leeway in science which this country had suffered during the preceding half century, as a consequence of the prolonged periods of interruption in our communications with the Continent of Europe caused by the wars of those days. The aims of the founders were clearly and wisely defined, and year after year the Association gathered strength and influence in spite of the early opposition to it expressed by *The Times* and numerous theologians and sectarians. Among its councillors and workers were many brilliant men—Brewster, Dalton, Forbes, Herschel, Faraday, Murchison, Baden Powell, George Rennie, and others of world-wide reputation. By 1873 all these pioneers had gone to their rest, and we could see no successors worthy to take their place. Decrepitude and decay had, we said, first begun to appear round about 1850. From that date onwards, so we alleged, the Association had shown an ever-increasing tendency to fall away from its early ideals. Of the chief elements constituting the decay, we gave first place to the composition of the Council. It was, we said, no longer composed of men renowned for their scientific labours, but included persons who had secured election to it by an abuse of patronage or because of their wealth, their rank, or their social or political influence. The management of the Association had become lax and misguided. In the Geographical Section annual attempts, we said, were made to provide a "draw" by lionising some notable individual. At Brighton in 1872 it had been Stanley, or, as we put it, "the flashy agent of a 'cute American newspaper which had sent him after 'our illustrious traveller' who would not himself communicate his whereabouts in Africa." At the Bradford meeting of 1873 it had been Sir Samuel Baker, fresh from having, according to his own account, extinguished slavery in Africa for ever. Neither of these men, we said, was scientific, nor had they pursued scientific work in the undertakings by which they had acquired popular fame. In the Mechanical Section opportunities for advertising trade objects had been widely seized by men with no pretensions to scientific research. The addresses of the Sectional Presidents had on the average become clap-trap utterances designed for the speaker's personal glorification. The evening discourses, with rare exceptions, had descended to the level of "mere flashy dissertations on things in general." Instead of promoting science, the Association had been tempted to make itself an organ for influencing the Government to pass laws which some of the members believed to be necessary or for extracting funds from the public to promote some crotchety object. It was meddling with public matters of various sorts, from education to total abstinence, with which it had no concern, and had opened its doors to cranks and humbugs to whom a hearing ought never to have been granted. . . . We cannot believe that all that we said on this occasion was meant to be taken seriously. That very year Joule was President of the Association, although ill-health had compelled him to relinquish the office before the annual meeting. That year, too, Clerk Maxwell delivered an evening discourse on "Molecules," which even to-day can be read with profit and pleasure. Sir William Siemens discussed "Fuel" and its utilisation, and we thought sufficient of his lecture to reprint five columns of it. In the Mechanical Section Osborne Reynolds had papers on the theory of propellers and guns, and Mr. (Sir) Wm. White lectured on "Channel Steamships." Balfour Stewart discussed "Ethereal Friction." Barlow, Berthon, James Napier and others whose names are still remembered to-day also contributed to the proceedings.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

TARS FOR ROAD PURPOSES.

No. 76—1930. An important modification has recently been made in connection with the instrument to be used for the measurement of the viscosity of Tar No. 2 contained in the B.S. Specification No. 76—1930.

Experimental research has confirmed the practicability of adopting the B.R.T.A. viscometer, already standardised for the measurement of the viscosities of Tars Nos. 1 and 3, for Tar No. 2 also, in place of the Hutchinson tar tester, and accordingly, the B.R.T.A. instrument has now been adopted as the standard for Tar No. 2. A Corrigendum slip—reference No. C.D. (P W) 950—setting out the necessary alterations to the published specification, may be obtained gratis on application.

DEFINITIONS AND SYMBOLS FOR WELDING AND CUTTING.

No. 499—1933. The rapid development of the art of welding, and especially of fusion welding, has introduced a technique and vocabulary which is all its own. The preparation of a standard list of terms applicable to the art, defining what each means, is clearly a matter of prime importance.

The Standard Nomenclature, Definitions, and Symbols for Welding and Cutting, which has just been issued by the British Standards Institution, has been prepared to meet this need.

Terms are, for ease of reference, grouped under five main sections as follows :—

Section I.—Definitions of general terms applicable to all forms of welding and also including cutting terms.

Section II.—Definitions of methods and joints relating to forge welding.

Section III.—Definitions of methods, terms, and joints relating to pressure welding.

Section IV.—Definitions of methods, terms, and joints relating to fusion welding.

Section V.—Definitions of terms relating to welding and cutting equipment and supplies.

A complete alphabetical index is included so that the definition number of any term can be easily found. Where desirable, in order to prevent the possibility of misunderstanding, illustrations and diagrams have been inserted.

A system of indicating welds on engineering drawings has been prepared in which a capital letter is used to indicate the general form of joint, such as "B" or "T" for a butt joint and tee joint respectively, and a combination of numbers and suffix letters is appended to indicate the particular form of weld. There is also a statement of the dimensions to be given.

Details of the working of the scheme are given in full, together with an explanatory chart; an illustration of each form of fusion welded joint is included and a weld symbol given to it.

It is held to be of particular importance that those entering the industry should, from the beginning of their training, use the definitions, terms and symbols now standardised.

As far as the symbols for indicating welds are concerned, the standard will become an essential adjunct to B.S.S. No. 308—1927, Engineering Drawing Office Practice, in which the usual symbols used on engineering drawings are standardised.

The price of the publication is 2s. 3d. post free.

Railway and Road Matters.

The recent scarcity of water in various parts of the country has drawn attention to the fact that the Great Western Railway pumps some 12,000,000 gallons of water from the Severn Tunnel which is discharged into that river.

What is known as motor trolley maintenance, which was originated on the Great Western and is now also used on the North-Eastern area of the L. and N.E.R., saves the provision of flagmen on single lines and more quickly conveys men and material to and from a job. The *Great Western Railway Magazine* for September reports that it is now under test for use on double lines.

The Railway Staff Census, just issued as a Stationery Office publication, covers the week ended March 11th, 1933. It shows that the number of railway servants on that date was 566,300, as compared with 597,971 in March, 1932, a decrease of 31,671, or 5·30 per cent. The more noteworthy reductions are: Engine drivers, 33,389 to 32,171; firemen, 31,144 to 29,832; goods guards, 13,842 to 12,906; labourers, 24,922 to 20,567; engine-shed staff, 9453 to 8480; permanent way men, 57,766 to 54,626; shopmen, 92,206 to 84,792; signalmen, 26,299 to 25,537. In the ancillary business the staff on the docks has been reduced from 12,783 to 11,552.

The name "London Passenger Transport Board," having been found to be too long for general use, it has officially been abbreviated to "London Transport." While that name will be used to describe the undertakings of the London Passenger Transport Board as a whole, the names of each of the forms of transport will continue in use. "General" will still appear on the sides of the omnibuses, and, similarly, Underground Railways, Green Line Coaches, Tramways, and Trolleybuses will still describe the various services. The full title, "London Passenger Transport Board," will also continue to be used where—as on the sides of the road vehicles—it is a legal requirement.

Since November, 1931, each system engineer, *i.e.*, divisional engineer, on the South African Railways has kept a record of the permanent way material on hand at each district depôt so as to ensure that no new material shall be ordered that can be obtained by transfer from one point to another. As a result, the value of the stock on hand has been reduced from £287,528 in 1929 to £118,272 in 1931, and the expenditure on material for maintenance purposes from £371,284 to £169,405. All the lines were inspected during the year 1931–32, particular attention being devoted to the state of the track materials. The inspections disclosed that the permanent way has never been in better condition.

In the last quarterly returns of railway accidents a fatal accident reported upon by Mr. Scott Main related to a gang of thirty-two men who were engaged in re-sleepering. The work, which was in the London area, had to be done at night, and the men assembled at the station concerned at 12.30 a.m. One man, however, went to an adjoining station, and, later, his dead body was found by the side of the line. The point we wish to bring out is that Mr. Main remarked that the ganger failed to have a roll call, otherwise the missing man's absence would have been noticed. The advisability, he adds, of taking this course when dealing with a considerable number of men on similar work is, he thinks, desirable.

The present week sees the centenary of an event which was mentioned in The Engineer of November 28th, 1924, in article XXII. of our series "One Hundred Years of British Railways." Mentioning the Dundee and Newtyle Railway, sanctioned in 1826, we said that when the line was opened in December, 1831, the three inclined planes were worked by stationary engines and the level portions by horses. On September 30th, 1833, two locomotives, the "Earl of Airlie" and the "Lord Wharncliffe," were put into service, and on March 2nd, 1834, the "Trotter" was added. All were of what is now known as the 0–2–4 type, *i.e.*, with a trailing bogie, and were the first locomotives in Great Britain to have that feature.

Remarkable speed records were established by the L.M.S. Railway between Euston and Coventry and *vice versâ* on Tuesday, September 19th, when two special trains were run in each direction for the accommodation of guests visiting the Humber-Hillman-Commer motor works at Coventry. The fastest run of all was made by "Flyer No. 2," returning from Coventry to London in the evening, when the 93½ miles from Coventry to a signal stop just outside Euston station were covered in 74 min. 20 sec., at an average speed of 75½ miles an hour start-to-stop. Including the signal stop of two minutes' duration, Euston was reached in the unprecedented time of 79 min. from Coventry. The maximum speed attained on this run was 92 m.p.h. at Castlethorpe, while 90 m.p.h. was touched before Weedon, near Watford, and again at Wembley. The train of seven coaches weighed just over 200 tons, and was hauled by the L.M.S. "Royal Scot" class engine "Comet," Driver B. A. Marchant and Fireman W. Aldridge, of the Camden (London) depôt.

The death, on September 18th, of Mr. David Bain, who was the carriage and wagon superintendent of the Midland Railway from 1901 to 1919, recalls the pioneer work done by that company in the provision of comfortable rolling stock. That work was begun by T. G. Clayton—who came from the Great Western—when new trains were necessary for the Anglo-Scottish service on the opening, in May, 1876, of the Settle and Carlisle line. During the brief interval between Mr. Clayton's retirement and Mr. Bain's appointment, Mr. T. P. Osborne was in charge. Mr. Bain maintained the good work done in those twenty-five years, but it was in detail rather than in principles. One innovation has done excellent work; that is, the shock-absorbing buffer to avoid telescoping. When Mr. John Holden, of the Great Western, retired, Mr. Bain succeeded him as chairman of the Committee for the Standardisation of Privately Owned Wagons. During the war he was Controller of Timber Supplies, and soon after the Armistice he intimated his wish to retire, being then over the age limit. He was succeeded by Mr. R. W. Reid, whose death, ten years later, will always be a pathetic memory.

Notes and Memoranda.

An electric motor of 1000 horse-power, recently built by the Westinghouse Company of America, which runs at 514 revolutions per minute, can be brought to a stop from full speed in 3½ revolutions. The rotor weighs over 3 tons.

An electrical machine for sorting postal orders has been devised for use in the Post Office. There are forty-one different denominations of postal orders, and, to adapt them for sorting in the new machines, newly issued orders are punctured in different positions. The fact that 214,000,000 postal orders were paid last year indicates that the machines will eliminate much manual work.

A paper by Dr. E. Mallett, issued by the Institution of Electrical Engineers, describes a wattmeter depending for its action on the use of two thermionic valves and a direct-current measuring instrument. Three forms of instrument are described, the first suitable for measuring the powers used in ordinary power work, and the second and third for measuring the small powers used in communication work.

Electrical engineers, states the *General Electric Review*, have used kilovolts, kilowatts, and kilovolt-amperès regularly, but have not felt the need for kilo-amperès. Yet if engineers investigating lightning keep on, it should not be long before kiloampères become commonplace. A measurement in Pennsylvania early this summer indicated a current of 60,000 ampères in a flash of lightning. A simple magnetic instrument developed in the General Electric Company's Laboratory at Schenectady was used in obtaining the measurement.

It is claimed by R. Treje and Professor C. Benedicks, of the Metallurgical Institute of Stockholm, that they have worked out a rational method for the electrolytic extraction of slag from iron and carbon steel, the residue being uncontaminated by iron hydroxide or basic iron salts. Electrolysis is performed in a vessel divided in two by a diaphragm. The iron specimen—surrounded by a collodion bag, carried by a floating wooden ring, for collecting the slag—forms the anode in a bromide solution containing sodium citrate. The cathode consists of a copper plate in $CuSO_4$ solution.

The contract for the design and construction of the new McDonald Observatory on Mount Locke in South-Western Texas, containing the second largest telescope in the world, has been awarded to the Warner and Swasey Company, Cleveland. The project will cost approximately 325,000 dollars, and will require 2½ years to complete. The telescope will be owned by the University of Texas and operated by the University of Chicago under a co-operative arrangement. The telescope is to be of the reflector type, approximately 26ft. long, with a main mirror 80in. in diameter, weighing 5000 lb. It will be housed in a three-storey observatory, 71ft. high, surmounted by a dome weighing 115 tons.

Speaking at the British Association, Major Church said that the present position in television is that pictures far better than those using mechanical reconstituting devices are now obtainable with cathode-ray receiving apparatus, but the Geneva Convention made absolutely no provision for the proper expansion and development of television in the broadcast band of wave lengths. The alternative to violating the international agreements affecting broadcast channel widths or developing an entirely new radio technique was to have local areas served by ultra-short wave transmitters, but many practical difficulties remained to be overcome before that was possible. Experimental short-wave transmissions of high quality, however, had already begun in London from the Crystal Palace towers.

Although exports of electrical goods and apparatus during August show an advance of £105,369 over the figures for the corresponding month of 1932, this improvement is more than offset by a decline from £270,516 to £156,288 in electrical machinery exports. A drop of £24,542 in imports was due principally to decreases of £16,975 and £16,738 respectively in the purchases of telegraph and telephone apparatus and unenumerated electrical machinery. Compared with July the value of exports was £15,637 lower, again on account of decreased shipments of electrical machinery. This decline would have been more severe but for increased activity in the telegraph and telephone section. Except in the case of incandescent lamps, imports generally exceeded the August, 1932, values, and were £64,903 higher at £255,294.

A synchronous motor operating efficiently at variable speeds by means of a new type vacuum tube control was recently demonstrated in the General Electric Company's test laboratories at Schenectady, U.S.A. The new control, a development by Dr. E. F. W. Alexanderson, is expected to be useful in many fields for operating A.C. motors at various speeds with remote control, an example being electric ship propulsion. With the turbine running at full speed constantly, the speed of the propeller motors can be varied by changing the frequency of the current fed to them through the vacuum tube control. Instead of the captain communicating orders to the engine-room for a change of speed, the new apparatus makes it possible for him to regulate the speed of the driving motors directly from the bridge. The motor demonstrated was 400 H.P. and the efficiency of the frequency converter 98½ per cent.

There is a description in the *Bulletin* of the General Electric Company of a new device which ensures the safety of passengers from being struck by sliding doors, whether they are operated by electric or pneumatic means. A beam of light is focused across the lift car entrance on to a photo cell. Passengers entering or leaving the lift must of necessity interrupt this light beam. The effect of breaking the beam ensures either that the doors remain in the open position or, if they have started to close, that they will open again. All the time the beam of light is broken it is impossible to close the doors to the lift. The whole of the necessary apparatus can be fitted on the lift car and thus only one unit per lift is necessary. A unit comprises an adjustable projector arranged to focus light on a self-contained photo cell set which operates relays in the motor room connected with the power doors. Structural alteration to standard types of lifts is not involved.

Miscellanea.

It is proposed to put up a gasmaking plant at Harbin.

It is officially announced that the blast-furnace of the South African State steel works at Pretoria will be blown in next January, according to schedule.

After being shut down for 2½ years, the Thurcroft by-product plant, Yorkshire, is again to start up. It is expected that the preparation work will take about two months.

The Corporation of Middlesbrough is contemplating the abandonment of some of its electric tramways, but has not yet decided as to whether the substitute shall be trolley omnibuses or motor omnibuses.

It is announced that a large aeroplane, capable of carrying 128 passengers, as well as the pilots and other members of the crew, has recently been constructed in Kharkov, and is undergoing a series of test flights.

It is proposed to re-open the Chalainor coal mine of the Chinese Eastern Railway, which was badly damaged during the military operations at the time of the Sino-Soviet conflict. The cost of the works is estimated at a million gold roubles.

The latest estimates of the probable average duration of the period of open navigation from the newly opened port of Churchill, Hudson's Bay, Canada, out into the Atlantic, give the dates of August 1st and October 20th as the opening and closing days.

It is understood that the War Department is considering tenders for a new vessel to be used for towing floating targets for artillery practice. The requirements call for a very special type of ship of the tug class, and a group of modifications and improvements will be embodied in the new vessel.

It is announced from Leningrad that the Soviet shipping department has begun the preparation of a scheme for the construction of the largest electrical icebreaker in the world, for service on the great northern sea route. Work has also been commenced on two smaller electrical ice-breakers, one of 4500 tons and the other of 1200 tons. All the three ships are to be ready by 1935.

After having been advocated for many years, a start is about to be made on enlarging the Dortmund–Ems Canal, and a preliminary sum of 6,000,000 marks has been set aside by the Reich Ministry of Finance for the execution of canal works. The Rhine allows the transport of ore and coal in large barges up to 2000 tons, while the Dortmund–Ems Canal can only take barges up to 750 tons.

Plans have been drafted for construction of a new railway station to accommodate the headquarters of the Shanghai-Nanking and Shanghai-Hangchow Railway Administration in place of the North Station, which was partially destroyed by Japanese bombardment during the Sino-Japanese hostilities in Shanghai. The site measures 10,000ft. by 3000ft., and the cost of the works is put at about £1,000,000.

One of the effects of a decision of the Canadian Government, according to the *Financial Times*, of Montreal, will be to permit the Royal Canadian Mint at Ottawa to extend its refining facilities to United States gold as well as to Canadian gold. Furthermore, the bulk of the United States annual production of gold, amounting to 40,000,000 dollars in value, will be smelted and refined in Canada. Smelting will be carried out in northern Ontario, and at Trail, B.C., but gold will be refined to the purer state at the Ottawa Mint.

High-frequency radio telephones have, says the *Engineering News-Record*, been installed at headquarters, field offices, and boats on the San Francisco-Oakland bridge work to improve communication facilities over the scattered operations now starting on the project. Both the engineering organisation and the two foundation contractors on the main channel work will make use of the system. The radio phones will eliminate countless trips by messengers on boats to remote pier locations, and are estimated to effect direct saving in time as well as provide closer contact in the working organisations.

Under an order recently circulated, the French Minister of Public Works reminds engineers of the Ponts et Chausées, of Mines, and of his Department that they render themselves liable to dismissal if, without having first obtained special permission from his Ministry, they carry out surveys for or give advice to private concerns. The Minister adds that where the regulations in this respect have been overlooked, and officials have not obtained the permission of the Ministry to carry out private projects or surveys, the Chief Officers should take immediate steps to stop this irregularity by acquainting him with all the particulars.

A project is under consideration, says the *Engineering and Contract Record*, of Canada, for the development of natural gas and oil resources in Manitoba and for the piping of the gas to the City of Winnipeg for domestic and heating uses. The site of the development is about 95 miles from Winnipeg, and it is understood that the promoters are meeting with excellent success in financing their undertaking. The cost of the pipe line is estimated at around 600,000 dollars, while the plant complete with power-house, refinery, and other necessary units, would involve an expenditure of 10,000,000 dollars or more. This development, should it proceed, will greatly stimulate business in Winnipeg and Manitoba generally.

The fifth blast-furnace to be blown in this year, and the hundred and seventh at present working in the Soviet Union, recently started production at the new Azov Steel Works in Mariupol, a port on the Azov Sea, in South-Eastern Ukraine. The Azov Steel Works have been designed for an annual production of 924,000 tons of pig iron. They will be equipped, in the first stage, with four blast-furnaces, thirty-one tilting open hearths, rolling mill equipment for the manufacture of rails, and a coke and chemical plant with an annual capacity of 1,300,000 tons. Among other divisions it will also include a large sintering and flotation plant that will prepare the ore to be brought from Kerch, a town on the other side of the Azov Sea.

THE OLYMPIA EXHIBITION—VARIOUS EXHIBITS

(For description see page 300.)

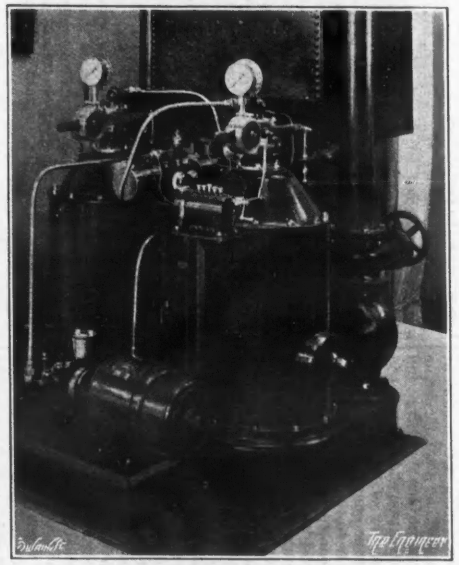

FIG. 100—SEWAGE EJECTOR UNITS—BENTLEYS

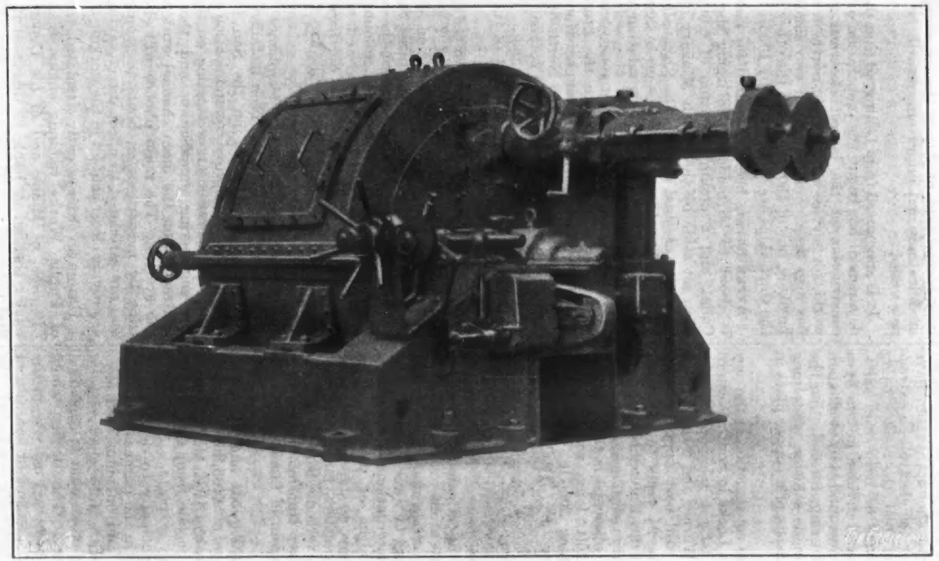

FIG. 101—65 INCH BULK CENTRIFUGE—SUPER CENTRIFUGAL

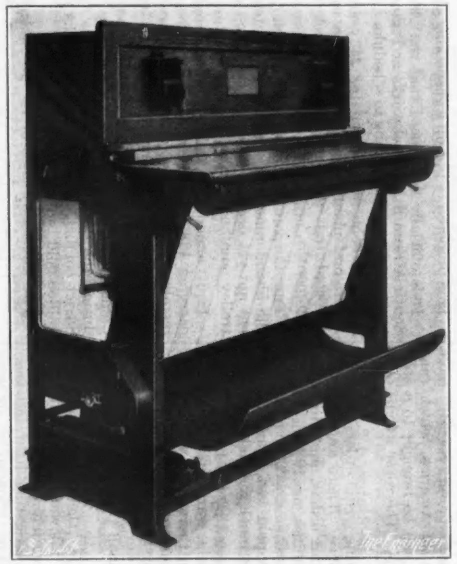

FIG. 102—OZALID PRINTING MACHINE—PRECISION PHOTO

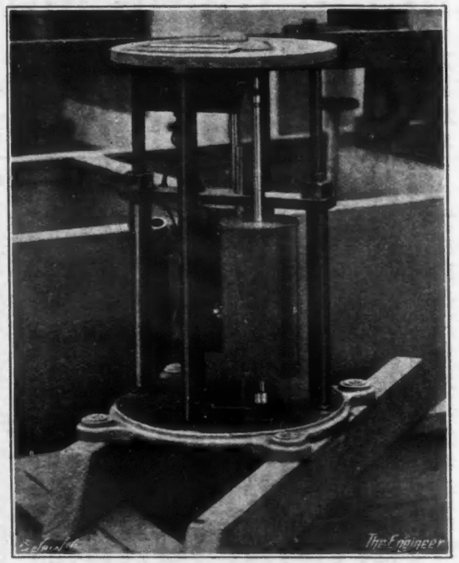

FIG. 103—LIQUID FLOWMETER—LEA RECORDER

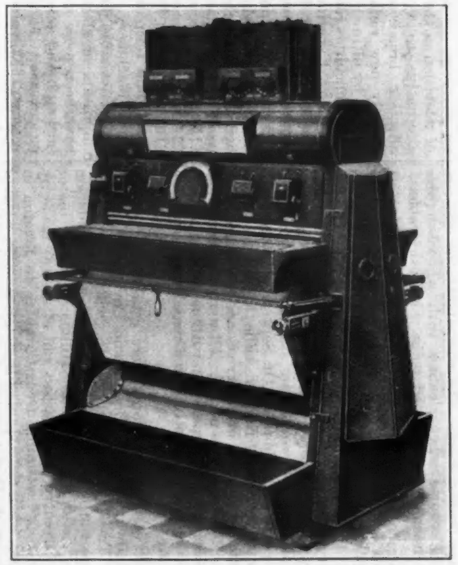

FIG. 104—PHOTO COPYING MACHINE—MASON

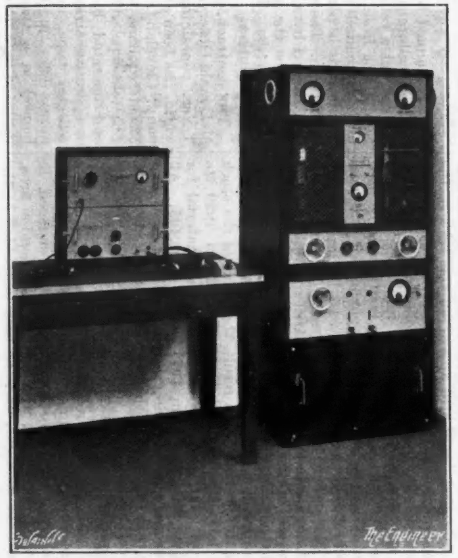

FIG. 105—RADIO-TELEGRAPHIC TELEPHONE INSTALLATION—MARINE ELECTRICAL

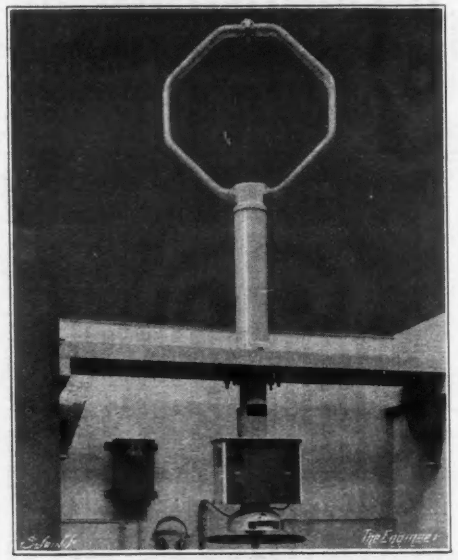

FIG. 106—DIRECTION FINDER—MARINE ELECTRICAL

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QUALITY AND PRICE.

WELL over a year ago the Federation of British Industries, and through it the British Standards Institution, received from the British Chamber of Commerce in the Argentine Republic a letter touching upon a subject of great importance to the export trade of British engineering firms. In that letter, which has not been made public, it was said that the quality of British engineering products was so high, and their price in consequence so great, that competition with rival manufacturers who were content with lower standards was very difficult. Commenting on the general terms of this complaint in our issue of June 3rd, 1932, we pointed out that whilst it was of old standing and had been frequently made by responsible people, it had never been seriously debated by British engineers. We expressed our conviction that in view of the manner of presentation the matter could no longer be shelved, but that it demanded, and we felt sure would receive, the most careful attention. Furthermore, we hoped that in due time the B.S.I. would publish the reply which it sent to Buenos Aires. That reply was despatched on July 10th last, and by the permission of the Institution we print it in full to-day. Some surprise will perhaps be felt at the long time it took to prepare. It must, however, be remembered that numerous bodies had to be consulted before a generally acceptable reply could be drawn up, and that the machinery of a great organisation depending upon the voluntary help of a great many people cannot easily be accelerated. The interval between question and answer, over sixteen months, is certainly long, but we may at any rate take it that its length indicates that the document now sent represents the considered view and opinions of the mass of British engineers.

The first fact that must strike the reader of the opening paragraphs of the letter is that the same attitude which has always been taken by British industry when faced with this problem is now adopted. Briefly, it comes to this, that whilst the British Standards Institution appreciates the spirit in which it has been approached by the Chamber of Commerce in Buenos Aires, it has found no sufficient arguments why it should depart from the standards which, with the general agreement of engineers, it has set up. It repeats the well-worn argument "that the reputation of British machinery has been built up on quality and durability, and that these characteristics have in the past proved effective from the point of view of sales." It even carries the war into the enemy's camp, so to speak, by affirming that the evidence collected "would appear to indicate that on the whole there would be very much to be gained by purchasers making use of British Standards and practices." It is impossible not to feel that whatever force there may be in these arguments is destroyed by the refusal, according to the Buenos Aires Chamber of Commerce, of the people of the Argentine to pay for the British standards of excellence. However proud we, as a nation, may be of them, however certain that other nations would benefit by following our example, we cannot get over the fact that our power of competition on price is weakened by an adherence to these standards. But the merits of British standards is not the sole argument advanced in their support. There is yet another old one which the B.S.I. employs. It reminds the Chamber of Commerce of "the economic difficulties of accommodating modern manufacturing methods to the very diverse requirements of numerous markets." Of the justness of that contention there can be no manner of doubt. Everyone knows that the essence of standardisation is the crystallisation of certain selected forms, and that departure from those forms involves increased manufacturing costs in any factory that has adopted them. But, again, it is manifestly fruitless to present those forms on a market which resolutely refuses to accept them, and which can obtain from other sources forms or qualities which it prefers. That is the quandary in which the British manufacturer is placed. By the conviction that his standards are the best possible compromises, and through the economic conditions which are imposed by their adoption, he places himself in the position, according to the British Chamber of Commerce in Buenos Aires, that he cannot sell his goods to the Argentine purchaser. No amount of argument can get round that uncomfortable fact. The B.S.I. has taken the greatest pains to reply in detail to the cases presented by the Chamber of Commerce, but none of the arguments it advances in support of British practice are likely to prevail appreciably with Argentine buyers, who, no doubt, will continue to purchase cheaper or lighter, or more heavily stressed, or less efficient machinery if it suits their pockets and their conditions so to do. Indeed, we hope more from the few promises of the B.S.I. to review certain of its specifications and by its efforts to get international agreement on certain matters than from its arguments in support of British practice.

Whilst there exists in this country no other body to which this great question, as far as it affects engineering, could have been referred, it must have been foreseen that the B.S.I. could scarcely give any answer different from that which it has given. The purpose to which it is now devoted, if not precisely that for which it was established, is the maintenance and extension of the principles of standardisation. Moreover, it is its boast, on good foundations, that the standards it prescribes are sanctioned and approved by the best engineering talent and experience in the country. It admits that in preparing its specifications "the conditions at home have played a dominant part, yet it can give as its honest opinion that on the whole foreign purchasers would be well advised to accept British standards." Holding these views, it would have been strange indeed if the B.S.I. had not replied to Buenos Aires in the terms set forth on another page. But it is difficult to escape the conviction that the B.S.I. found the complaints of the Chamber of Commerce so inimical to all its principles that it could not review them with complete sympathy. Hence, save for the distant hopes which arise from the prospects of international agreement on a few issues and the promise to reconsider certain specifications, the position remains exactly as it was, and foreign competitors will continue to prevail against British engineers in the Argentine as much as ever. We are still faced by the fact that the standards which are considered desirable by this country are higher than the standards desired by other countries. Therein lies the problem that remains to be solved: how to secure the advantages of standardisation whilst giving the foreigner the quality, the design, and the price that appeal to him. The B.S.I. does, it will be observed, suggest a possible course. Whilst rejecting the introduction into its specifications of different grades of quality for home and export, it invites the Chamber of Commerce to strengthen the Local Committee of the Institution and to transmit to London criticisms of existing specifications. "The question," it continues, "would then be one as to whether the proposed modifications would be generally acceptable for all markets, or whether they could only be applicable to the Argentine market, and might *have to be issued under the ægis of our Argentine Local Committee.*" The suggestion of differential selection conveyed by the words which we have italicised opens possibilities which may, if they prove practicable, have fruitful results. It is satisfactory to know, as reported in the second letter of the B.S.I., that in South Africa "the standard set by British Standard Specifications is a definite asset rather than a disadvantage in securing business in that market," and it is reasonable to hope that South America may in time be brought to the same frame of mind. But in the meanwhile something has to be done to retain our position in that market. Once lost, it will be difficult to regain, and some concession to its requirements may be a wiser policy than unbending adherence to specifications which do not appeal to it.

Power Cultivating Machinery.

THE satisfactory use of motor cultivating machinery does not depend upon any generally applied principle of agriculture, except the economic necessity of decreasing costs and increasing profits. The manner in which builders of tractors and other power machinery for tillage purposes approached the problem was revealed for many years at the annual official demonstrations held in France, and the International Exhibition of machines organised by the State Comité Central de Culture Mécanique at Arpajon last week, when the machines were shown in operation on a field, indicated that agricultural engineers are finding a solution of the problem in a selection of tractor types that differ essentially from those which in the past were demonstrated at these gatherings. The idea that influenced the researches of engineers at the beginning of the movement in favour of the tractor was that the farmer must necessarily use power machinery for cultivation in order to put more land under crops and reduce proportionately his costs. Tractors were being employed on the big cornfields in North America, and during the war many hundreds of such machines were brought over from the United States. Subsequently, they were purchased by the State and distributed all over France and in the African Colonies. They were not a success. They, nevertheless, demonstrated the possibility, and even the necessity, of adopting power mechanism for ploughing at a time when the country had to increase its production of cereals under conditions of labour scarcity. The years that followed were a period of experiment, when makers exercised their mechanical ingenuity with little knowledge of what farmers needed, and agriculturists, not being mechanics, could render little assistance. They watched with interest these efforts to help them, though refusing to purchase machines without a definite guarantee of saving in cost. The slump that followed the period of agricultural prosperity left the tractor industry in a serious condition. In those countries that merely aim at producing sufficient cereals for home needs the farmer does not generally want to increase the area of ploughed land. The cultivating machine must therefore allow more profit to be made out of every acre tilled. Now that the engineer has emerged from the trial-and-error period, there is an elimination of types of machines that do not fulfil these conditions. Improvements in others added interest to the French demonstrations to which we have just alluded.

The problem that confronts the tractor builder is complicated by the varied conditions under which agriculture is carried on in different countries. It is largely a question of population and labour. At the present time, farmers in Central Europe find it cheaper to employ men than to use machines, and in North Africa native agriculturists, who were induced by enterprising salesmen to purchase tractors, now condemn them as the cause of their trouble, although the real reason is the unprofitable prices of grain, and, more especially, the lack of mechanical ability to use the machines economically and keep them in good order. The problem has, therefore, entered upon a new phase, now that an extensive, and in many cases unfortunate, experience has enabled tractor builders to find a solution with every promise of success. Progress in France has been retarded by an objection on the part of farmers to use petrol, which is expensive and entails risks that add to their insurance charges. The State sought to impose the use of a "national fuel," incorporating a percentage of alcohol, but this mixture failed, and the evolution towards the use of heavy oils and the introduction of the high-speed solid injection oil engine was therefore inevitable. At the French demonstrations there was not a single heavy tractor running on petrol. All the machines had settled down to a somewhat uniform type, and as during the past two or three years heavy oil engined tractors have been selling, despite the crisis in the agricultural industry, there is every indication that the machine evolved for cultivation and general farm purposes has started upon a new period of practical and progressive development. The troubles incidental to wheel adhesion are being tackled by the low-pressure pneumatic tire with some promise of success. It should presumably economise fuel consumption relatively to the work done and conduce to a lessened cost of upkeep, whilst it appeals to the user by removing restrictions imposed on steel-tired tractors on the road. To this extent, therefore, the outlook for the agricultural tractor is distinctly hopeful. In a country like France, which is being entirely electrified, for electricity is distributed throughout all the rural districts, it might be supposed that electrical tillage machines would enter largely into agricultural practice. If they have failed to make more progress it is not for lack of enterprise. Yet of firms which have entered into this experimental field only two remain. An extensive employment of electrical ploughing machines depends upon reduction of cost. The farmer in France, as in this country, is not satisfied with the electrical distribution. He finds that the price of current is too high, that the conditions imposed upon him are too onerous, and that the electricity companies cannot afford to install mains that will carry sufficient load to enable a number of farmers in a district to plough at the same time during a few days of the year. Hence electrical cultivation is practically at a standstill. Then there is the class of small farmers who constitute the enormous majority of machinery users in the country. Here, again, it was hoped that an almost unlimited field would be opened up to the engineer who could provide a type of light tillage machine at low cost. An international committee was constituted, with headquarters at Lausanne, to investigate the whole problem of a small general purpose tractor, and trials and competitions were organised for a machine that could be assembled with standard parts to be stocked in all agricultural centres. Nothing appears to have come of these efforts to create an international standardised type of cheap tractor for small farmers. The problem, therefore, remains to be dealt with by individual makers, some of whom achieve encouraging results. At the French demonstrations the motor tillage implements shown, generally fitted with small air-cooled petrol engines, have a practical application, and this branch of light mechanical tillage offers a wide scope to the engineer because the required conditions can be met economically in many different ways.

The main conclusion arrived at after an inspection of the machines at the French gathering is that the agricultural tractor, both for medium and light cultivation, has developed in a way that will give a progressive activity to the tractor industry as soon as agricultural conditions tend to become normal. For the heavier class of machines the universal adoption of the high-speed heavy oil engine is but another indication of the position which the compression ignition engine is clearly destined to take in all classes of haulage and transport.

25 Years' Progress in Metallurgical Plant.*

By W. R. BARCLAY, Vice-President.

I.—DEVELOPMENTS IN MELTING AND CASTING EQUIPMENT.

As a convenient starting point for a review of this section, we may recall for a moment the type of casting equipment in common use in the early years of the present century. The great majority of the non-ferrous manufacturing works in this country were equipped only with crucible furnaces of the pit type—for the most part coke-fired. A limited use was made of oil or gas fuel for metals and alloys of high melting points, such as nickel and its richer alloys, but the furnaces used even for this type of product were essentially of the conventional crucible type. The main development prior to the period now being considered was the provision of forced draught and mechanical tilting. So far at least as non-ferrous metals are concerned, electric furnaces were non-existent. At that period the only furnaces which, to the works' metallurgist, held out any substantial promise of successful operation were the Héroult and the Kjellin types. The former is an arc furnace, the latter an induction furnace, and the proposals for electric melting of non-ferrous metals most favoured at that time were those embodying the "resistance" principle. To make use of the ordinary crucible and surround it by graphite or other refractory resistance elements electrically heated was a natural suggestion arising out of conventional practice. Investigation of the possibilities of this type of furnace, however, quickly revealed not only the practical difficulties, but also the serious problem of securing anything like economic operating costs. It was really the advent of the Ajax-Wyatt low-frequency induction furnace which made the electric melting of brass and copper alloys generally a commercial success and led to the adoption of electric melting on a wide scale.

During the last ten years progress has been exceedingly rapid. In the non-ferrous industries both the arc type and the induction type of electric furnace may be said to be definitely established. The resistance type of furnace has also been developed with considerable success in the melting of aluminium and aluminium-rich alloys. For copper and its chief alloys, induction furnaces of the Ajax-Wyatt and Russ designs are most generally favoured. For higher temperature metals, such as nickel and its alloys, the arc furnace of the Héroult type is most popular. The latter type of furnace design has been appreciably varied by different makers both in Europe and America, but in essential principle all such furnaces depend on radiation heating by the electric arc.

From a technical point of view, the most interesting advance of the latter part of our period is the introduction and development of the "high-frequency" induction furnace, due in the main to Northrup in the United States. This furnace is a modern development, made possible only by advances in the science of electrical engineering, and as a melting proposition, at least in theory, presents extremely attractive features to the metallurgist, since it provides the possibility of melting under conditions ideally suitable for the exclusion of extraneous impurities. It must be admitted, however, that the high-frequency furnace is more suitable for high than for low-temperature alloys, and consequently its adoption in the non-ferrous metals industry has been somewhat slow. The high-frequency furnace as at present designed is, unfortunately, a somewhat costly proposition in capital expenditure, and it cannot be claimed that it is appreciably more economical in power consumption than the arc furnace. These facts have undoubtedly retarded its progress in the non-ferrous industries. Up to the present time its main use in this field lies in the production of high-purity nickel-containing alloys.

Before leaving the subject of metal-melting equipment, perhaps I may be allowed for a moment to deal with a question which I have been repeatedly asked during the last few years—namely, how does the cost of electric melting in this country compare with that of coke, gas, or oil-fired crucible practice so far as non-ferrous metals are concerned? The difficulty in replying to this question is one relating largely to the scale of production. It is unquestionable that with furnace linings of modern composition and construction, and electric energy at anything like a reasonable price, electric melting is decidedly more economical than coke-fired crucible melting, if the quantity dealt with is sufficient to keep an electric installation reasonably fully employed. For production on a small scale, and particularly where a large number of individual and special alloys is made, the coke-fired crucible furnace still holds its own in this country.

Moulds.—The production of liquid metal, from whatever form of furnace, is, of course, only one stage in the production of ingots. A further radical factor in casting equipment is the ingot mould. In this type of equipment again considerable developments have been witnessed, the most important of which is undoubtedly the advent of the water-cooled mould. This development, like many others in modern metallurgical practice, was under discussion long before it became a practical proposition. The chief credit for its industrial evolution must be given to Otto Junker in Germany, and Erichsen in Sweden. The designs adopted by both makers are based essentially upon the use of a mould lining of copper or some other suitable alloy, surrounded by a steel jacket through which provision is made for a continuous flow of water, hot or cold. The lining of the Junker mould has always been of copper. Erichsen, on the other hand, developed the idea of using a nickel-iron alloy of the Invar type, and claims thereby certain improvements in results in solidity of ingot casting.

The advantages and disadvantages of the two types of mould are somewhat controversial and need not be considered here. What must be said is that the advent of the water-cooled mould marks a decisive stage of progress towards the industrial production of sounder ingots. Amongst the advantages of the water-cooled mould is the possibility of obtaining uniform temperatures throughout practically the whole period of solidification. It must, however, be pointed out emphatically that the use of such a mould does not remove the need for strict attention to the other factors essential to the production of sound ingots, particularly the "feeding of pipe."

Apart from the possibility of obtaining more accurate temperature control, the principal advantage secured by the water-cooled mould is economy in casting costs; this is without doubt very considerable. In the use of the older type of cast ingot mould, the wastage, particularly where fairly high temperature alloys were being produced, was extremely serious, and was no small factor in the cost of ingot production. Some very remarkable results illustrating this point were obtained in the earlier days of experimental work with such moulds when I was engaged in their development for the casting of nickel-brasses. With the older type of mould it was no uncommon thing for a set of moulds to deteriorate after three weeks' work so seriously as to necessitate either removal from service altogether, or complete reconditioning. In contrast to this, one of the earliest water-cooled moulds that I installed was in continuous service for more than eighteen months, and even at the end of this period the surface of the inner lining was in a much better condition than the best of our cast iron moulds.

The introduction of the water-cooled mould is, however, by no means the only improvement in ingot casting practice which the last quarter of a century has witnessed, and, although only brief reference can be made, I must not omit mention of such improvements as the introduction of the Durville system of casting. This is the outcome of a study of the technological factors involved in the pouring of molten metal into ingot moulds. As you are aware, the Durville principle is that of tilting the mould as well as the molten metal container during the operation of pouring metal into the mould, thus producing cast ingots with only the minimum of disturbance in the liquid metal immediately before and during solidification. There can be no doubt that this type of mould and the improvements in casting technique thus developed by the work of Genders and his colleagues at Woolwich, under the auspices of the British Non-Ferrous Metals Research Association, have made possible the casting on an industrial scale of several metals and alloys which would otherwise present almost insurmountable difficulties.

II.—ROLLING MILL MACHINERY.

The development of rolling mill machinery, whilst perhaps not so fundamental in nature as that which has occurred in casting equipment, has, nevertheless, been important and perhaps even more impressive, particularly in the production of sheet and strip metal. Twenty-five years ago the general equipment of practically all non-ferrous rolling mills in this country consisted of what are termed "train rolls," *i.e.*, a series of two-high mills of various sizes driven by one prime mover (steam or electric) and linked up either in series or parallel by reduction gearing. In many cases an entire mill equipment of fifteen to twenty pairs of rolls was driven from one prime mover by the aid of a large and heavy fly-wheel. Several such mills driven by the old "Watt type" of beam engine still remain in this country.

It must be admitted that these mills were usually run at a low cost per unit of power in the prime mover, but their disadvantages increased seriously as demands became more diverse and erratic, as in the case of modern industry. Since 1908, and particularly since the outbreak of the war, "train mills" have repeatedly given place to mills "individually driven" by electric power. The chief advantage of such individually driven mills is that if a considerable quantity of sheet or strip metal of similar widths and gauges is in demand, such mills can be run independently and continuously without regard to other mills or subsidiary plant, the product of which may temporarily not be required. The advent of the individually driven mill has led to a revolution in rolling mill design.

The non-ferrous rolling mill of a generation ago consisted of rolls and housings and wobblers and pinions almost literally thrown together, with little regard either to precision in construction or economy in power consumption. A modern individually driven mill, whether of the two-high or the more complex type, is, on the other hand, a precision machine, designed and built with all the skill and attention to detail required in a high-grade machine tool. As a consequence, the rolling process has become much more scientific, the percentage of reduction during passes more uniform and regular (with obvious advantages to uniformity in cold working), and gauging is more accurate, both in cross section and longitudinally.

A specially important feature of the modern precision cold-rolling mill is the adoption of hardened nickel-chromium steel rolls with water-cooling devices. Such rolls have a scleroscope hardness of from 95 to 100 and possess remarkably good surfaces. Their outstanding advantages to the metal roller are:—

(*a*) The improved surface obtainable on cold-rolled sheet or strip metal;

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* Twelfth Autumn Lecture to the Institute of Metals, delivered September 18th, 1933. Abridged.

(*b*) The retention of uniformity of camber and greatly reduced liability to distortion during heavy service.

Both of these factors are particularly important in finishing operations.

During the last few years considerable publicity has been given to the more complex individually driven mills of the four-high and six-high (cluster) type. Such mills should certainly find an important place in any review of rolling development in our industry. In some respects they represent a further improvement even on the precision two-high mill, particularly when for any reason, metallurgical or economic, appreciable percentage reductions per pass are required. The answer to the question as to whether the installation of four-high or six-high mills is advisable depends entirely on conditions, and on more than one occasion I have in certain circumstances advised the erection of a two-high rather than a four-high mill. The more complex mill, with its backing-up rolls and roller bearing equipment, is undoubtedly economical in power, and with properly cambered working rolls is exceedingly accurate in product, and capable of giving big reductions with uniformity of gauge, but its advantages cannot be either demonstrated or experienced unless the type of output required is suitable. These complex mills are essentially "mass production" machines, requiring quantity and standardisation of product in order to realise their full possibilities. The industry as a whole is, unfortunately, not yet "standardised," and in meeting the varied demands which come to the manufacturer of rolled metal products in non-ferrous metals to-day, it is often more economic to continue to use the two-high mills rather than incur the increased capital cost of the four-high or cluster mill. At the same time, I hold strongly that the introduction of these latter mills is a further step forward in rolling mill design, and it will, I believe, pave the way in the future to still greater improvements.

A further development of cold rolling mills is the Steckel mill, which, although not as yet at all widely adopted in the non-ferrous industries, deserves at least a brief mention. This mill is a distinct departure from conventional rolling mill design, both from an engineering and metallurgical point of view. The metallurgist regards cold rolling as a process of cold working, and is therefore able to appreciate the essential difference between the type of cold working effected by the ordinary rolling mill operations and the type effected by "drawing" such as is carried out in the production of rods, wire, and tubes, in which the crystal grains of metal are drawn one over the other and elongated more or less uniformly, instead of being compressed in one direction only. The fundamental principle of the Steckel mill is the subjecting of strip or sheet metal to the latter type of cold working rather than to the former. The strip to be cold rolled is passed through small working rolls which have an action corresponding rather to that of dies through which metal is drawn than to that of rolls subjected to pressure. The metal is fed into these working rolls from drums which are electrically driven and capable of rapid reversal. The working rolls of the Steckel mill are exceptionally small (2in. to 2·5in. in diameter), and have consequently to be supported by backing-up rolls. The drive is almost entirely by tension on the strip itself, and the small rolls thus constitute in effect a frictionless rotary die. It is claimed for this mill that by its use considerably greater percentage reductions can be obtained without intermediate annealing than by any other method, and those of you who are aware of the greater percentage reductions usually obtainable in the operations of "drawing" as compared with those of "rolling," will appreciate the possibility of such a result.

Hot Rolling.

During recent years the importance of hot rolling has been more widely appreciated, and it is being more and more generally adopted as the result of our increased knowledge of the possibilities of hot working in the production of a large proportion of industrial non-ferrous alloys. Not many years ago it was considered that very few such alloys could be hot rolled, 60 : 40 brass being an outstanding exception. To-day in modern plants even alloys of the nickel-brass type may be, and are being, hot rolled.

In the earlier part of the period under review very little change occurred in the mills put down for hot-working non-ferrous metals. They were almost invariably two-high mills of the purely conventional type. Since the war, however, a change of a kind not dissimilar to that which has occurred in cold-rolling plant has occurred also in hot-rolling mills, and practically every hot-rolling mill put down since the period at the end of the war has been of the individually driven type, with a number of detailed improvements which have raised the standard of efficiency and accuracy.

The majority of the mills recently erected for the hot rolling of non-ferrous metals are probably of the three-high type, but several important modern installations, particularly for the hot rolling of copper and brass, consist of two-high mills, although these depart in many ways from the older designs. I wish particularly to direct attention to the factors making for greater precision, *e.g.*, the development of machine-cut helical gears; the greater width of pinions and their improved mechanical design, with provision for more efficient lubrication; the mechanising of screw-down gear, with the adoption of fine adjustments; and the remarkable improvement in coupling spindles. Not the least of the recent advances in detail of construction of the modern rolling mill is the provision of automatic lubrication, which effects considerable economies in power consumption while at the same time lengthening the life of wearing parts.

Before leaving the subject of rolling mills I must make brief reference to the latest of all developments in this field. I refer to what is known as the Hazelett rolling process, on which considerable experimental work is now being carried out in the United States of America. While this cannot be regarded as a development brought to completion within the period under review, I feel justified in referring to it, since the experimental work which has led up to it certainly belongs to this period. It must, I am sure, have occurred often to observers of the processes of casting and hot rolling that considerable loss of heat energy, as well as delay in processing, occurs in the cooling down of ingots and their re-heating for rolling purposes. The Hazelett process seeks to remedy this. Instead of using the normal ingot mould, molten metal is poured between water-cooled rollers in such a way that immediately the metal begins to solidify the rollers can be set into operation and the process of reduction to sheet be begun almost instantaneously.

III.—Rod and Wire-drawing Plant.

In this field new developments of machinery have scarcely been so far-reaching as in the other fields already surveyed. Cold-drawing benches for rods and tubes remain to-day much as they were twenty-five years ago, except for modification in engineering details such as direct electrically driven worm gearing. The improvements in rod and tube production during the period have been by no means negligible, but such improvements have resulted from factors other than the process of cold-drawing. The improvements arise mainly from the increased use now being made of extrusion processes.

In wire-drawing machinery, however, developments have been very considerable, and are in some degree comparable with those in cold rolling, particularly in regard to the greater precision and efficiency of modern machines. The production of rod and wire involves, of course, the operations of both rolling and drawing, and in both these sections improvements in the design of equipment have been effected. The modern rod and wire rolling mill, while not widely departing in fundamental principle from earlier designs, has been so greatly improved in detail of construction that it can be not unfairly compared with the improvement in the two-high rolling mill.

The improvements effected in wire-drawing machinery are considerable and important. Exigencies of time and space prevent me from dealing with these at such length as I would like, and I must confine myself to generalities rather than to details. I am glad to be able to say, however, that British engineers have been active in this field, and some of the wire-drawing machines produced by British manufacturers compare very favourably indeed with those on the Continent. I am more happy to say this here since it was scarcely possible to say it twenty-five years ago.

It is interesting to note that these improvements have not been primarily in connection with details of design, but have arisen from what may be termed "the greater realisation by engineers of what is required by metallurgists." The essential principle in wire-drawing is to obtain absolute uniformity of cold work throughout the cross section of the wire being drawn. The requirements, therefore, are obviously that the wire shall enter the die at exactly the proper angle, in order to meet the bevel of the die with mathematical accuracy round the surface to be drawn. In the past this point has not been by any means universally realised by designers and manufacturers of wire-drawing machinery, and there can be no doubt that improvements in this respect constitute the most important modifications of the modern machine.

On the other hand, detailed improvements such as that of effecting a large number of reductions in one continuous series of drafts has also led to no inconsiderable increase in efficiency and economy.

Although not coming strictly under the head of wire-drawing machinery, I think that it is necessary to refer briefly to the development of dies during this period, and particularly to composition dies of the "tungsten-carbide" type. These have to some extent replaced both diamond dies and steel dies, and their use has certainly led to great improvements in the life of dies, better service, and more accurate gauge. The bugbear of the wire-drawer is, of course, the fault known as "pulling out," that is to say, the change in section effected in the hole of the die by irregular wear. The very much harder surface obtainable from these composition dies as compared with the older steel dies is a considerable factor in the progress made in this direction.

IV.—Auxiliary Equipment, Annealing Furnaces, and General.

In this final section of my review of development I propose to deal briefly with a few auxiliary items of non-ferrous metal mill equipment, and also with the subject of annealing furnaces.

Improvements of importance, both in principle and detail, have been effected in appliances for the machining and preparation of ingots for rolling; in the shearing and flattening of sheets; and particularly in the bright finishing and polishing of sheet and strip metal.

We have witnessed also during the last few years a remarkable advancement in polishing machines, which, while scarcely involving new principles, has yet led to appreciably wider applications of rolled sheet and strip metal. The surface finishing of metal has unquestionably been given much greater attention during the last few years than previously, and the product of "mirror finished" rolls on the one hand, and modern grinding and polishing equipment on the other, has brought into being an entirely new standard of finish of metal surfaces; indeed, the technique of surface finishing of rolled strip and sheet metal is to-day on a far higher level than it was even so recently as three to five years ago. The use of rolls with mirror finish is now very widespread, particularly on the Continent, and it is worth while to mention that experience in the use of these rolls has directed attention in greater degree than ever before to the subject of the surface quality of metals.

The obvious limitation of mirror-finished rolls in the production of sheet metal is that some amount of "work-hardening" is inevitable, and if dead-soft metals are required, the material must subsequently pass through an annealing process.

This point leads directly to the subject of annealing, for there is no doubt that the far higher standards demanded to-day in surface finish have stimulated serious and often anxious inquiries into the possibilities of improvement in the annealing process. It is of little use to attain a high standard of surface finish on metal products if such finish is to be immediately destroyed by the operations of annealing and pickling. It is, perhaps, too much to claim that the problem of bright annealing of non-ferrous metals has been solved within the period of our present survey, but at least it may be said that it is well on the way to solution. Outstanding problems relate mainly to the working out of the most economical methods of technique.

A movement towards the construction of more efficient annealing furnaces had begun in the period between 1910 and 1915, and furnaces built on the semi-producer gas-fired principle came into use about that time in several newly constructed works and extensions. It was really this movement which started the evolution of the modern annealing furnace, since, for almost the first time in the construction of annealing furnaces for non-ferrous metals, a systematic study was made of methods for securing uniformity of temperature and efficiency in fuel consumption. That the ideal annealing furnace is not yet an accomplished fact does not in any way detract from the testimony due to the intensive efforts of furnace engineers during recent years.

While the development of electric annealing furnaces is certainly the most remarkable and symbolic of our times, tribute must be paid to the work of gas and oil engineers in improving enormously the efficiency and reliability of annealing furnaces heated with these fuels. A similar remark applies to developments in the design of furnaces using powdered coal. In this field, as in others, competition has been healthy, and has certainly been of inestimable advantage to the non-ferrous industries at large.

Extrusion.—There are yet many further developments of the last twenty-five years which deserve passing mention, but time does not permit. I cannot close, however, without referring briefly to the subject of the extrusion of metals. It can scarcely be claimed that the extrusion press itself has undergone any considerable transformation, at least, so far as fundamental principles are concerned, but extrusion presses of recent design and construction are, as a rule, much more powerful and convenient of control than those of twenty or twenty-five years ago, and they are also equipped with auxiliaries which make for greater efficiency and economy in operating. The range of extruded products has, consequently, been greatly widened.

A point that I wish to emphasise particularly, however, is that the non-ferrous engineer and metallurgist has during recent years entered into a much fuller appreciation of the value and potentialities of the extrusion process, not only as a method of direct production, but also as a hot-working process of definite metallurgical value.

Extrusion has during recent years become more than a means of producing a special type of product. It has begun to occupy an important place in the "flow of operations" of mills producing metals in forms other than extruded sections themselves. A case in point which will occur to you at once is the important part played by extrusion in the production of special alloy tubes. Wider possibilities are also opening out, and I have seen extrusion presses in some degree taking the place of hot-rolling mills in the production of strip metal by the attractive method of extruding, *e.g.*, a rectangular brass section of, say, 3·5in. or 4in. wide, 0·25in. thick, and afterwards cold-rolling it to bright finished strip. The relative accuracy of gauge and width obtainable in such an extruded product renders it a very attractive proposition for the modern high-speed precision mill. One is tempted to visualise in the not too distant future important extensions of the application of this idea.

The British Association.

No. III.

(Concluded from page 239, September 22nd.)

SECTION G (Engineering) concluded its sessions with a short meeting on Wednesday morning, September 13th, when one paper was read and discussed and three reports of Committees were presented. The President (Mr. R. W. Allen) was again in the chair.

STEEL EMBRITTLEMENT.

The authors of the paper were Messrs. A. M. Kay and R. N. Arnold, and they dealt with a number of comparatively long-time tests on various steels, in which the effect of time and temperature on embrittlement has been studied. Mentioning the desirability of any steel in practice sustaining the normal load conditions imposed upon it without deterioration during its possible life of service, the authors point out that among the disquieting features that have arisen in recent engineering development is the phenomenon of "age embrittling" of steel, which displays itself by the serious embrittling, or diminution in resistance to shock, of machine components when subjected to working conditions at elevated temperatures, a phenomenon which has been repeatedly revealed in steam and other plant subject to similar conditions. Recent research has indicated that certain alloy steels are susceptible to this embrittlement if maintained at a high temperature for a considerable period, but hitherto a systematic survey covering the phases of composition and physical state has not been attempted. A series of long-duration tests, therefore, has been carried out on various alloy steels in which dangerous embrittlement was exhibited only after long periods; in some cases as long as 1000 hours elapsed before severe embrittlement was encountered. In addition to alloy steels, some work has also been instituted on the embrittling of mild steel with time, after quenching from temperatures below the lower change point. The authors say they are not aware of any publication dealing directly with this defect in mild steel, and they are at present attempting to discover the mechanism of failure. It would appear, they state, that the failure due to the embrittlement of both alloy and mild steels is traceable to the same fundamental cause. This work—the results concerning which given in the paper relate only to the preliminary investigation of what is a very extensive subject—is being carried out at the Sheffield University under the supervision of Professor F. C. Lea, and has been rendered possible by financial assistance from the Department of Scientific and Industrial Research and the trustees of the Sir James Caird's Travelling Scholarship.

The paper describes in detail the methods and apparatus used in the investigations, and the authors arrive at the following conclusions from their work on alloy steels:—

(*a*) The ultimate embrittlement produced by soaking at temperatures from 300 deg. to 650 deg. Cent. is apparently independent of the temperature, but the rate at which the change occurs is more rapid as the temperature is increased.

(*b*) Working stresses play no apparent part in the embrittlement.

(*c*) Serious embrittlement is apt to occur in steels which contain approximately 3 per cent. nickel and 1 per cent. chromium.

(*d*) Molybdenum up to 1·5 per cent. acts as a retarding agent, but does not appear to affect the ultimate embrittlement.

The embrittlement studied in various types of steel seem, in general, to reveal the following features:

(*a*) The embrittlement is perceptible by a considerable decrease in impact resistance.

(*b*) During embrittlement the hardness varies only within small limits.

(*c*) The variation in ultimate tensile strength during embrittlement is small.

(*d*) The structures do not change appreciably as viewed under high magnification.

With regard to suggestions which have been made as to the cause of embrittlement, the authors express the view that the idea that deposition of carbides at the grain boundaries accounts for the phenomena is a doubtful explanation, as in both alloy and mild steel the embrittled structures have been examined, and no carbide has been detected at the boundaries. Furthermore, the microscope has shown that impact fractures are transcrystalline, and there is no certainty that fracture begins at crystal boundaries. It seems probable, they say, that the change in the embrittled steel is of a sub-microscopic nature. It may be that the material is attempting to attain a condition of equilibrium, and that precipitation of some constituent is taking place. In the case of mild steel it is well known that cementite (Fe_3C) is slightly soluble in ferrite. This solubility increases with temperature below the change point, so that after quenching the steel may contain dissolved Fe_3C which tends to separate with time. A long period may elapse before precipitation is complete, owing to the high forces which resist internal movement at atmospheric temperature. Precipitation, however, may be impossible at this temperature, owing to the force-resisting movement being much greater than in mild steel. An increase in temperature will relieve these forces to some extent, and may leave the material in a state which will permit the precipitation of unstable constituents. It is probable that such precipitation would result in straining the crystal lattice, and leaving the metal embrittled. However, it is not possible to put forward a more satisfactory explanation until the fundamentals of this complex problem have received more intensive analysis.

DISCUSSION.

Sir Henry Fowler said the most important question before engineers was the relation of impact and fatigue, and although he himself had not worked at temperatures as high as those used by the authors, yet the statement made by them that, in spite of the fact that there might be tremendous variation in the impact value, the fatigue value only dropped a little was of great interest. With regard to the authors' experiments at room temperature, he inquired whether that was definitely ascertained to be 20 deg. Cent. because with certain steels, particularly those with a high carbon content, a variation of a few degrees made a material difference in the impact value. He gathered that the authors' tests on alloy steels had been carried out immediately after quenching, but he did not think the effect of the small amount of ageing which took place in an ordinary tensile test was generally known. Some time ago, with a steel containing 0·6 or 0·7 carbon, it was found that the desired elongation results were not being obtained, and, as the result of a series of special tests, it was found that keeping a test bar for three or four hours after it had been quenched very materially affected the elongation, but not the tensile strength. Undoubtedly, however, the elongation was increased very materially with the comparatively small amount of ageing in that short time. He also inquired whether the tests were taken by the ordinary Brinell or the diamond hardness method.

Sir James Henderson referred to the intense local stresses set up by the Izod test, and inquired how far they might have affected the results given in the paper. Moreover, owing to quenching, there was possibly a very high state of stress on the outer skin of the material, which, together with the high temperature, might start surface cracks, and it would be interesting therefore to know if the authors had done any microstructure work to detect the presence of microscopic cracks before applying the Izod test and also afterwards.

Dr. S. J. Davies said that there was not yet a fundamental impact test. The ordinary impact test gave an indication of the shock-resisting properties of steels, but the results were, nevertheless, very vague and empirical. It was some years since he had been concerned with testing materials, and he had hoped that something new would have been found in that particular direction in the interval. All that could be said of the Izod test was that it was very useful, but not very scientific. He inquired of Sir Henry Fowler how he measured fatigue. Was it by the Wöhler test?

Sir Henry Fowler replied that he used the Haigh test.

Dr. Davies, continuing, said that since such tests were empirical a very large number were required, and as the length of time involved in making them was very considerable, it occurred to him that there might be collaboration between users for the purpose of obtaining reliable results. There was a fairly good idea, for instance, in the case of oil engines, of the mean temperature of the exhaust valve and in the case of an oil engine running under a fairly steady load, as in a marine engine, very useful results might be obtained if Professor Lea could collaborate with some superintending marine engineer to put valves of different steel into the engines. Quite a number of junior engineers were going to sea after having taken a degree at a university, and those young men would be very glad of the opportunity of doing some such scientific work, in addition to the routine work they had to carry out. At present there was a lack of data, and it was necessary to invent ways of removing it.

The President, speaking from the point of view of a designer, said that in the case of steam turbines working at from 400 lb. to 500 lb. steam pressure and 800 deg. Fah. temperature, there had been great difficulties owing to embrittlement with the bolts which secured the two halves of the turbines. Indeed, it had developed into a perfect disease all over the country at one time, and it was not confined to large turbines. After consultation with the late Sir Charles Parsons, the trouble was overcome by increasing the length of the bolts by four or five times. In the case of oil engines, trouble arose every day through embrittlement, and what was wanted was a suitable material from metallurgists, because the design was all right. Up to the present it could not be said that there was a material for bolts which overcame that difficulty. Nickel-chrome had been tried without altogether satisfactory results. In the case of the Blue Funnel line, which had a nearly complete fleet fitted with oil engines, there was a routine by which all the bolts were taken out of the engines once a year and re-annealed to prevent danger of failure from supposed fatigue.

Mr. McKay, replying to the discussion, said that owing to the limited number of furnaces available at the Sheffield University, it had not been possible to carry out work on the relation between embrittlement and fatigue, but now that it had been found that stress played no part in embrittlement it might be possible to do some work on those lines, and get some useful results. As to the effect of the variation of a few degrees from atmospheric temperature, a series of tests round about atmospheric temperature showed no difference in the results due to that variation. The hardness tests had been carried out with the diamond hardness testing machine. He agreed with Sir James Henderson as to the possibility of getting a high state of stress on the surface after quenching, but he believed, in the case of the tests, they were removed because the original 0·75in. diameter bar was afterwards turned down to 0·45in.

Mr. Arnold, who also replied, said that as to elongation increasing with time, very few steels to-day were in a stable condition after manufacture. Minute changes always took place, but whether they would be serious, he did not know. In some cases of mild steel the changes were immense, but in others they were difficult to detect. He believed steps were taken in the tests to prevent any sort of crack starting, as the result of the Izod test, because the notches were cut after heat treatment and quenching. He believed Professor Haigh had worked with slow impact tests for some time, but the results were very much like the results with the ordinary impact test.

Literature.

Plastic Working of Metals and Power Press Operations. By E. V. CRANE. London: Chapman and Hall, Ltd. Price 25s. net.

THE scope of this book is not quite so wide as its title, which should, presumably, include rolling and wire drawing, whereas only power press operations are considered. The presses described are chiefly of the crank shaft type, including excentric and toggle mechanisms; but presses of other kinds—that is, screw presses, hydraulic presses, and drop hammers—are briefly mentioned. The book deals with the behaviour of the metal worked, and, to some extent, with the shapes of the working faces of the tools. It does not concern itself with the design of presses.

The author is a member of the staff of the E. W. Bliss Company, and, in consequence, not unnaturally sings the praises of the power press. He attributes the enormous increase in output per man-hour which has taken place in recent years in the motor car industry more than in any other (in America of course) to the increased use of pressings instead of castings, &c. Examples are given showing how various articles have been made of various metals. It is claimed that much machining has been eliminated by the high order of accuracy which has been obtained in pressing.

With regard to the design of tools, it is admitted that the cut-and-try method cannot be entirely dispensed with, either in the design of tools to cut a blank of desired weight or volume, or in the design of cupping tools to give a cup with a flat top, or a top of any other desired shape.

It seems strange in a volume of this kind to see the structure of the atom discussed. Two chapters are, however, devoted to theoretical physical metallurgy for the purpose of explaining what takes place during plastic flow. These two chapters seem to belong to another book, being quite different in character from the remaining chapters, which embody a practical man's experience in dealing with the problems of his clients.

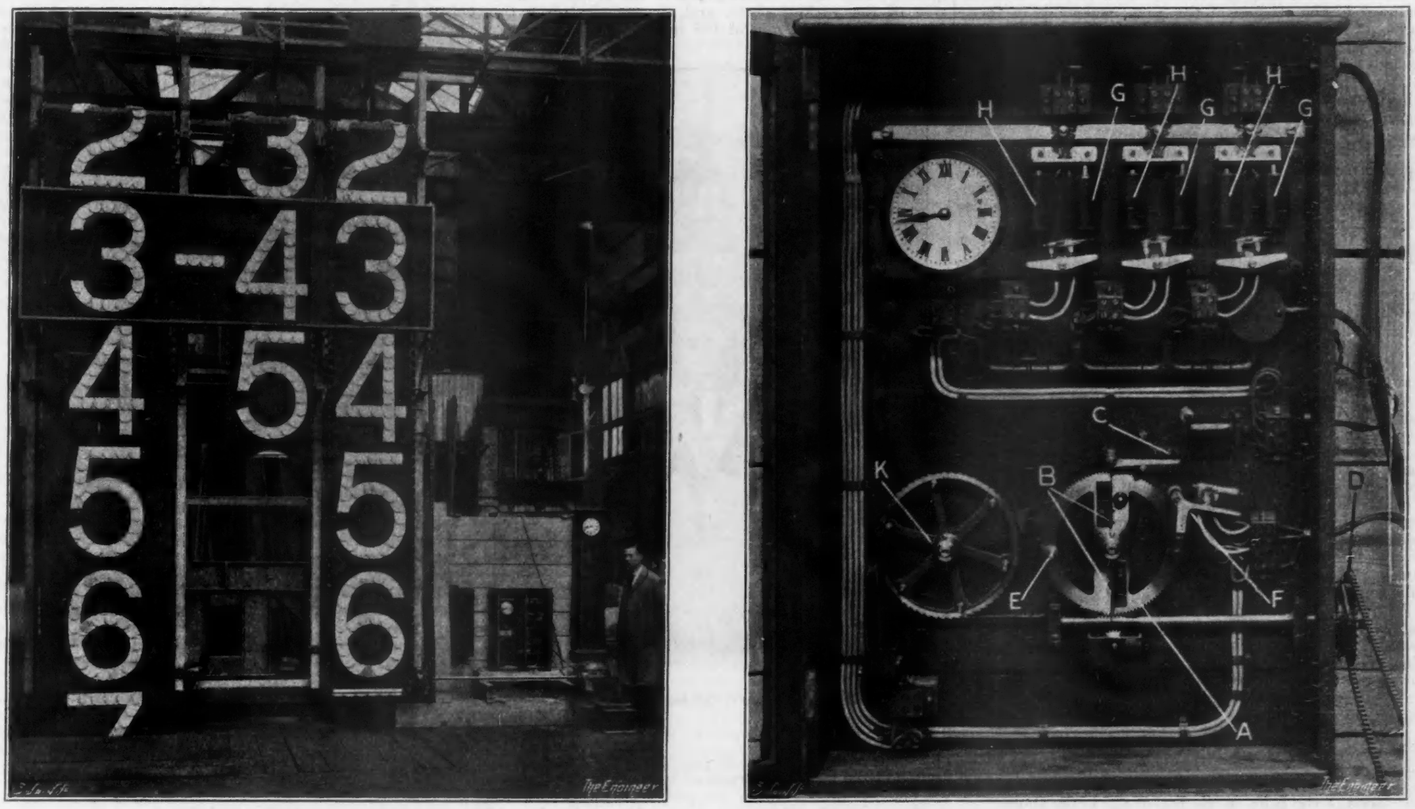
The book is full of footnotes giving references to the technical literature on the subject, nearly all the references being to American publications. It is also profusely illustrated with diagrams and photographs, all the latter being of machines of Bliss's manufacture, or of articles made in them.

Automatic feeding devices for the mass production of small articles are mentioned, but no examples are described; but safety devices to prevent press operators from injuring themselves are not even mentioned.

There are two appendices, the first consisting of a number of nomograms for the graphical calculation of the loads on the press for given operations, the capacities of given presses (taking the crank shaft as the criterion), and various other things; and the second of a number of problems to be solved by the reader by reference to the first.

CHRONOSCOPE CLOCK AND CONTROL MECHANISM

GILLETT AND JOHNSTON, CROYDON, MAKERS

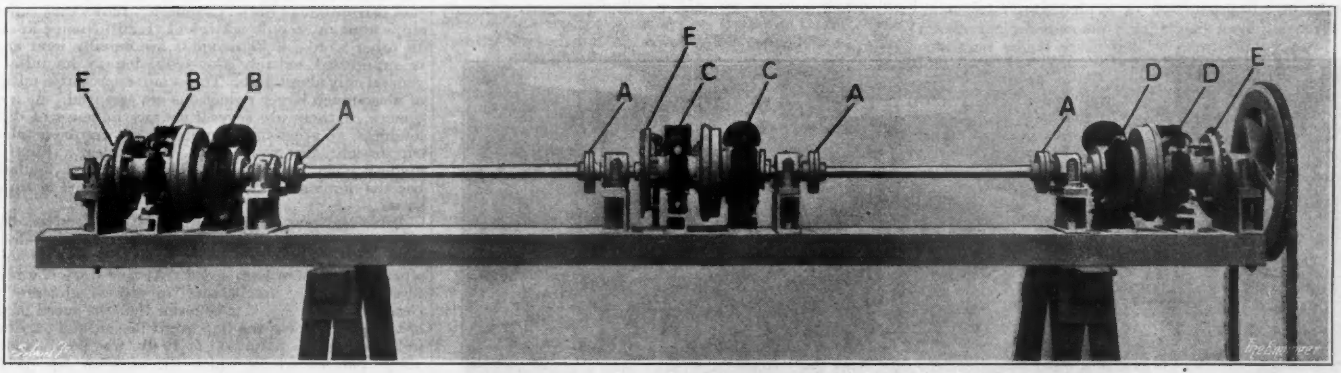


Chronoscope Clock for Paddington Station.

◆

PROMINENT amongst the features of the reconstructed Paddington Station, London, will be a giant electrical chronoscope, the largest in the world. This novel timekeeper, recently constructed by Gillett and Johnston, Ltd., Croydon, dispenses with the usual form of clock dial and indicates the hours and minutes by means of large figures, which appear in a rectangular frame and are changed at the appropriate moment by a controlling electric clock.

The sets of figures, one for the hours, a second for the tens of minutes, and a third for the digits of minutes, are mounted upon three endless bands, built up of steel slats. These slats are jointed at the ends by Delta metal links, which serve the dual purpose of providing a flexible joint between successive slats, and of transmitting the drive to the belts by engagement with the slots in the operating sprockets. Each belt has independent motion, and the movements of all three are controlled by a series of clock-actuated relays. The power for making the figure belt movements is supplied by a continuously running electric motor of ¼ H.P., coupled through a worm reduction gear to a shaft carrying the drive pulley of a heavy whittle type "V" belt.



BELT DRIVING SHAFT WITH EPICYCLIC GEAR UNITS

The driving sprockets of the figure belts are positioned at the upper ends of the belt-supporting framework, and serve both to support and operate the belts, while at the lower ends of the belts steadying rollers are fitted to ensure smoothness of action. The whittle belt transmits power from the motor to a shaft located behind the figure belts, and about 3ft. below the driving sprockets, and upon this shaft are mounted the three epicyclic gear units by which the master clock controls the movements of the figures.

A separate gear unit is provided for each figure belt, and the units are completely self-contained. Between each gear unit and its neighbour the driving shaft is divided and a flexible steel coupling, A, A, A, A, see illustration below, interposed. This precaution was taken to ensure the greatest possible freedom of action.

The epicyclic units themselves consist of a central "sun" gear of nickel steel, keyed to the driving shaft, and meshing with three phosphor-bronze "planet" pinions which, in turn, engage with a steel internal gear. This internal gear is attached to a brake drum, and the component carrying the studs on which the planet pinions run is also provided with a brake drum. A pair of externally contracting brake shoes, B B, C C, D D act upon each of these drums, and in the normal position, when the figures are stationary, the brake acting upon the planet pinions is held gripped to its drum under spring pressure, while that of the internal gear is held free of its drum by similar means.

Attached to each pair of brake shoes is a standard Marryatt and Scott brake magnet, and the windings of both these magnets are connected in series. Their action when energised is to reverse the position of the brake shoes, freeing the planet pinion component, and locking the internal gear. While no current is flowing in the brake magnets, the internal gear, being free, revolves idly, but when the reversal of action takes place the component carrying the planet pinions immediately begins to rotate, and by means of a chain sprocket, E, E, E, mounted on it, transmits its movement to the figure belt to which it is coupled. The final chain drive to the figure belt is by a Renolds chain, ⅜in. wide and of 1in. pitch.

Dealing next with the control panel, above, the main portion of this consists of a worm and worm wheel A, driven by a light chain from the continuously running shaft of the whittle belt drive pulley. The selected ratios of this mechanism provide that the worm wheel of the assembly will rotate once in slightly less than one minute, and this wheel is fitted with two spring catches B, B, at opposite points on its diameter. These catches engage with an electro-magnetic trigger release C, included in the circuit of the master clock, and as the worm wheel is completing its half revolution in slightly less time than half a minute, each of the spring catches will fall upon the locking pallet of the trigger release and remain there until the master clock impulse at exactly the half-minute unlocks it and permits it to proceed. The driven sprocket D on the worm spindle is fitted with a friction clutch which allows of it slipping round on the spindle when the spring catches are locked, but enables the drive to recommence its action the instant that the locked catch is released.

Mounted on the rim of the worm wheel is a trip pin E, and at one point, immediately after the release of the wheel at the completion of each full minute, this pin engages with and rocks over a mercury tube switch F. This, in turn, completes a circuit energising the "on" solenoid G of the minute relay. The relay is provided with two solenoids, one for making and the other for breaking the circuit it controls, and the relay is so constructed that it will remain in the position in which it is left by the last solenoid acting upon it, even after the solenoid circuit is broken.

With the completion of the circuit through the "on" solenoid, a second mercury switch, that of the minute relay, is tripped, thus closing the circuit through the brake magnets of the epicyclic gear controlling the movements of the digit minute figure belt.

The belt will then move until the next figure appears in the rectangular frame. The breaking of the brake-magnet circuit is controlled by the belt movement itself, for the belt-driving sprockets are constructed to make one complete rotation during the movement of each figure, and the spindle of the sprockets carries a quadrant arm for switching purposes. The action of this quadrant is to trip yet another mercury switch and energise the "off" solenoid H of the brake-magnet relay just as the belt movement is completed, thereby opening the brake circuit and stopping further movement of the figure belt until the pin on the worm wheel of the control panel causes the whole process to be repeated.

The action of the two further relays controlling the movements of the tens of minutes and hour figure belts is identical with that described, but a further break is included in the circuits of the "on" solenoids in these cases. These breaks take the form of simple contact points, their closing at the correct moments being controlled by pins mounted on a count wheel K, having sixty teeth, which is stepped one tooth each time the worm wheel revolves. By this means the circuits through the ten-minute and hour relays are only completed at every tenth and sixtieth minute respectively.

The only operation which the master clock is called upon to perform is the release of the trigger holding the worm wheel, yet by means of this the whole mechanism is synchronised to show accurate time. A small impulse dial is mounted in the control panel cabinet in order to indicate time and facilitate the checking of the figure belt positions.

The figures appearing on the belts have been designed to be particularly legible. They will be illuminated by flood-lighting, and as the rectangular frame in which they appear will be surrounded by a neon tube advertising sign, it was decided that the mere painting of the figures was insufficient. To give them special prominence, therefore, they are provided with circular reflectors of a special type. These reflectors are of glass, silvered and mounted in sealed metal holders, and they are very efficient in increasing the visibility of the numerals. Considerable ingenuity has been necessary in attaching these discs of glass to the slats of the belts in such a manner as to follow the shape of the figures without causing interference with the bending of the belts during the change of figures, but by careful positioning of the securing bolts this has been satisfactorily accomplished. The hour belt has twelve numerals, the minute belts five and ten respectively. The three belts together weigh over three-quarters of a ton.

Throughout the whole installation care has been taken to render the action as simple as possible, and to minimise the attention required for maintenance. To this end, ball bearings and grease-gun lubricators are employed wherever possible, and it is expected that the only attention necessary will be the periodical cleaning of the reflectors.

An interesting detail of design is the fact that the belts are self-positioning, for, as the breaking of the magnet circuits is controlled by the belt movements, the switching will occur at the correct moment independently of either the speed of the belts or the grip of the brake shoes.

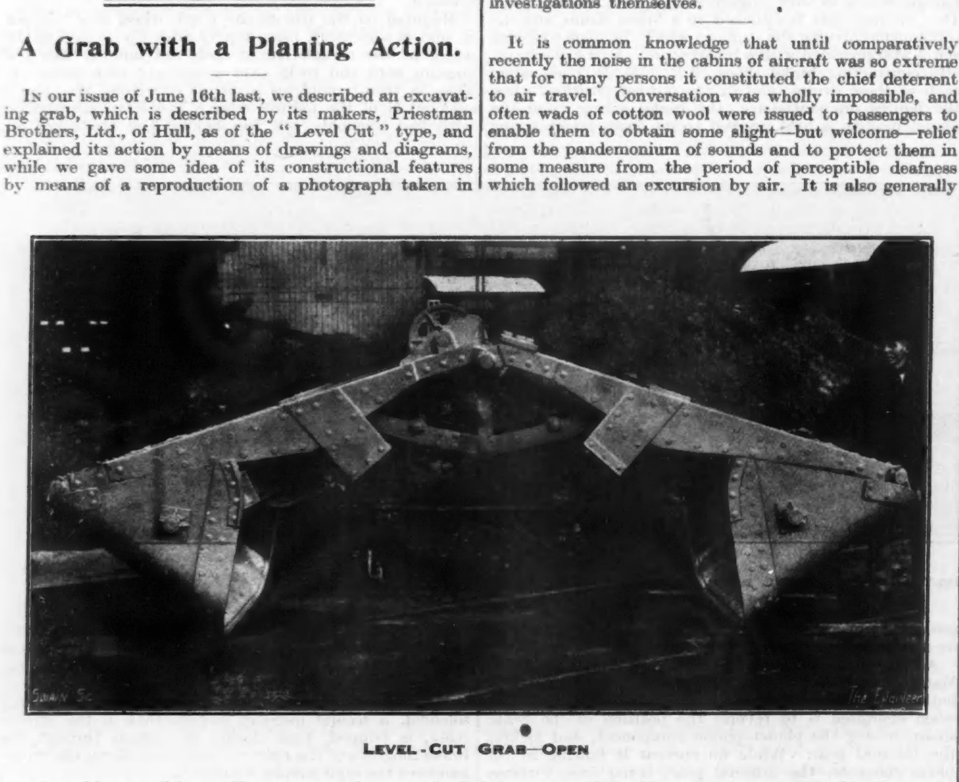
The current for operaton of the chronoscope is drawn from the 230-volt A.C. mains supplying the station. The driving motor is connected to these, while other feeders supply two sets of transformers and rectifiers. The larger of these provides the brake magnets with 140 volts D.C., and the second gives an output of 6 volts D.C. for the control panel circuits.

A feature of the installation is that it shows the hours and minutes in time-table form. This will relieve the travelling public of the necessity of transposing clock dial indications into time-table time, and will thus effect a saving of mental effort.

The timepiece will be installed by William Whiteley, Ltd., and the contract for its construction was placed with Smiths English Clocks, Ltd., in association with whom it has been designed and manufactured by Gillett and Johnston, Ltd.

A Grab with a Planing Action.

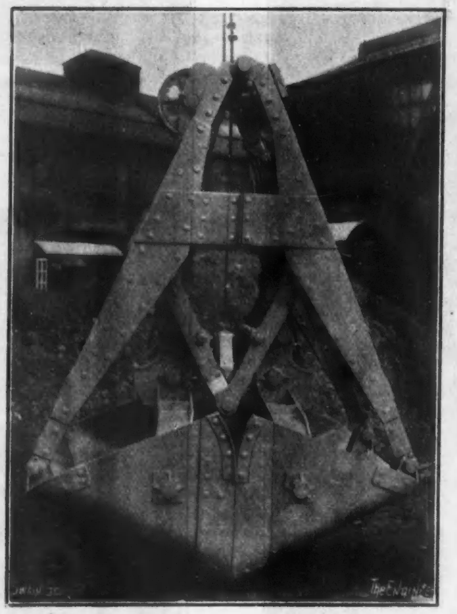
In our issue of June 16th last, we described an excavating grab, which is described by its makers, Priestman Brothers, Ltd., of Hull, as of the "Level Cut" type, and explained its action by means of drawings and diagrams, while we gave some idea of its constructional features by means of a reproduction of a photograph taken in actual working conditions. Since then, we have received from the makers two further photographs, reproduced herewith, that illustrate admirably the style of the grab and its action.



LEVEL-CUT GRAB—OPEN

It will be remembered that the object aimed at in the design of this grab is to produce a cutting action of the lips of the buckets in a horizontal plane, so that the bottom of the excavation is level, and not marked with a number of pot-holes, as is the case when a clam-shell grab is used. This action is provided by pivoting the buckets on two sets of interconnected levers and drawing them together by means of a horizontal purchase (the movement of the levers is described in our previous article).

The new pictures also show how the closing rope is kept well clear of the ground in digging, and is, consequently, relieved of much abrasion, the robust construction of the various parts, and the care taken by the makers to prevent *any* of the nuts from slacking back by securing them with split pins. It will be noticed that buffers have now been arranged between the bucket arms to take the pressure when the grab is closed.



LEVEL-CUT GRAB—CLOSED

The grab illustrated has a capacity of 1 cubic yard and weighs 33 cwt. Its height when closed is 9ft. 6in. and 5ft. 6in. open. The width is 4ft., and the spread of the jaws approximately 13ft. 6in.

Silencing Aircraft.*

By A. H. DAVIS, D.Sc., Physics Department, the National Physical Laboratory.

In 1929 a Sub-Committee was formed, by the Aeronautical Research Committee, to investigate the subject of aircraft noise. Various aspects of the work have received attention, and the present paper is an attempt to summarise the general conclusions in a form suitable for the aircraft industry, without reference to the results of the investigations themselves.

It is common knowledge that until comparatively recently the noise in the cabins of aircraft was so extreme that for many persons it constituted the chief deterrent to air travel. Conversation was wholly impossible, and often wads of cotton wool were issued to passengers to enable them to obtain some slight—but welcome—relief from the pandemonium of sounds and to protect them in some measure from the period of perceptible deafness which followed an excursion by air. It is also generally known that the cabins of certain recent aircraft are so much quieter than those of earlier types that conversation is comfortably possible and no after-deafness is noticeable.

It is not so well known how such improvement has been attained and the necessary steps are indicated below.

A Simple Scale of Noise.—Firstly, however, it would be well to realise that quite simple methods of measuring noise have proved adequate in studying the fundamentals of the problem. The sheer loudness was so great that refinements were not necessary, and a method was used in which a note of controllable loudness was produced in a telephone earpiece by means of a simple buzzer and electrical circuits. With the telephone earpiece held to one ear the current was adjusted in comparatively coarse steps (each increasing the output of sound energy by about 3·2 fold) until the sound emitted was judged to be as loud as the noise heard in the other ear. The loudness of the comparison note was read from the scale of the instrument in "decibels" above a standard zero at the threshold of audibility.

It is not necessary to discuss fully what a decibel is. It suffices to say that for all practical purposes a decibel is a definite fractional step (26 per cent.) in sound energy. The human ear works rather in a percentage or logarithmic manner, and at any ordinary loudness level a change of 1 decibel (26 per cent. change in energy) is the smallest loudness change the ear can detect. Each stud of the instrument corresponded to a step of 5 such "degrees" or decibels ($1\cdot26^5=3\cdot2$).

A series of loudness levels obtained by the writer are given in Table I. It may be remarked that, starting with a note at the threshold of audibility and gradually increasing its loudness, it is found that the sound becomes painful at about 120 db. above threshold. Again, conversation is normally impossible, even by shouting, when the noise level is of the order of 100–110 decibels above threshold—a condition which used to obtain in the cabins of passenger aircraft. Conversation is possible at a distance of a foot or so when the noise level is about 90 db., and may be carried on, though with difficulty, when—as in a tube train—the level falls to 75–80 db. The degree of comfort of conversation in trains (50 db. quiet–70 db. noisy) is well known.

TABLE I.—*Loudness Level of Various Noises.*

(Expressed in terms of the intensity in decibels above a standard "threshold" of a standard note of equal loudness.)

Loudness of comparison note decibels above appx. threshold (1 millidyne cm.^{2}).	At home.	In street.	In vehicles.	Airscrew and engine noises.
120	—	—	—	—
110	—	—	Noisy aeroplane.	Thick airscrew, high speed (80ft.).
100	—	—	—	—
90	—	Pneumatic drill.	Very noisy tube train.	Unsilenced exhaust (80ft.).
80	Very loud radio.	Motor horn (80ft.).	Tube train.	Silenced exhaust (80ft.).
70	Loud radio music.	Accelerating traffic.	Quiet aeroplane; train.	Thin airscrew, low speed (80ft.).
60	Loud radio speech.	Moderate traffic.	Bus; train.	—
50	Conversation.	Quiet car.	Quiet train.	—
40	Soft radio music.	Quiet London street.	Saloon car (25 m.p.h.).	—
30	Rustle of leaves.	Quiet street (town).	—	—
20	Quiet garden.	—	—	—
10	Quiet whisper.	—	—	—
0	Approximate threshold of audibility.*			

* Sound pressure of 1 millidyne/cm.^{2}.

It is necessary to notice an important consequence of the fact that a change of 26 per cent. in the energy is only just perceptible (1 db.). Calculation shows that three such steps amount to only a twofold ($1\cdot26^3$) change in energy. In other words, if two sounds are equally loud and one is suppressed entirely the reduction in loudness is in general only about 3 db. To get any appreciable mitigation of noise much larger reductions are essential. As a consequence, if there are several sources of noise of different loudness, no appreciable improvement can be attained by suppressing any source but the loudest. Firstly, the loudest must be reduced. Then the next loudest will become dominating, and must be suppressed in turn, and so on.

Airscrew Noise.—A comparative study upon test benches of the separate sources of aircraft noise—airscrews, engines, exhausts—showed that airscrews dominated when they were of high speed. At this stage it was therefore of primary importance to reduce airscrew noise. Generally speaking, it is believed that the speed of the tip of the airscrew was the important factor, and experiments indicated that a reduction of 10 db. was possible for each 100ft. per second by which the airscrew tip speed was reduced.

Many airscrews have tip speeds of 850ft. per second and even higher, and reduction to 550ft. per second would thus give 30 db. improvement. The quietest aircraft in which measurements have been made so far have airscrews with tip speeds of only 550ft. per second. The effects of other factors—blade setting, diameter, &c.—were small compared with the speed effect, but thin aircrew section was found to be preferable to thick, and there was probably advantage in four blader airscrews as compared with two-bladers.

Airscrew flutter must be avoided. In multi-engined machines something akin to flutter may occur when the slipstream of a front airscrew overlaps that of an airscrew further to the rear. This occurs in some machines when they yaw and gives rise to considerable bursts of noise, as well as to more rapid deterioration of the blades.

Engine and Exhaust Noise.—The adoption of large slow airscrews involves the use of reduction gear in the engine. Screaming of gears might be expected to arise, and might be serious in critical cases, but the evidence available from existing machines indicates clearly that the introduction of gearing to reduce extreme airscrew noise is well worth while.

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* Extracted by permission of the Controller of His Majesty's Stationery Office from the Aeronautical Research Committee's R. and M., No. 1542.

At present engine clatter may be considerable and even comparable with the noise of an airscrew of medium speed. Almost certainly enclosed water-cooled engines are less noisy than unenclosed air-cooled ones. Probably the reduction of engine clatter represents one of the directions in which further advance is urgently needed, say, by confining the engine in a housing or by suitable modification of moving parts. The sleeve valve engine, which is being developed for use in aircraft as the result of investigation by the Aeronautical Research Committee, should be relatively quiet owing to the absence of poppet valve gear, and may prove to be favourable in reducing noise when it has passed the experimental stage.

At the present time exhausts of engines are not silenced to any considerable extent, and the exhaust is of the same order of noisiness as the engine. Generally speaking, silencers which will withstand the extreme conditions met in aircraft do not at present give much more than 10 decibels reduction of noise—an order of result that can be attained by the use of an exhaust pipe perforated with a large number of small holes which split the gases into a large number of small jets as they impinge on the air.

Experiments at the Royal Aircraft Establishment, Farnborough, have shown that reductions of the order of 35 decibels can be attained with silencers which get very hot internally, but which nevertheless withstand endurance tests. In view of the fact that petrol may gain access to a heated silencer when an aircraft crashes, consideration is being given to the extent to which silencers which become hot internally can be regarded as safe. The result quoted, however, is sufficient to indicate that improvements in exhaust silencing may be looked for.

Favourable Location of the Power Plant.—It should be noted that there are a number of simple common-sense features in the design of aircraft which tend to locate the passenger accommodation away from the sources of noise, or to screen the cabin from them. Particularly where airscrews are of high-speed type they should not be situated immediately to the side of passenger accommodation. In some designs of machine the tips of high-speed airscrews have been within 2ft. of the heads of passengers, with only a thin celastoid window intervening, and the machines have been exceptionally noisy. On the other hand, in a number of machines having high-speed airscrews well forward, in front of the cabin, the conditions in the cabin are comparatively quiet. This particular arrangement leads to increased noise in the region of the pilot's cockpit and possibly the best arrangement would be not to place the power plant so far forward, but to locate luggage or lavatory accommodation near it. This disposition is a feature of some of the quieter British models. In any case, when the cabin is between the wings of a biplane, engines and exhausts should not be situated there also, because in this way sound is entrapped between the wings in the vicinity of the cabin. Rather, exhaust outlets and engines should be situated above a wing or in some similar position where they are screened from the cabin. Long exhausts discharging well behind the cabin have been adopted on some machines.

There is, however, another path by which noises may reach a cabin, other than direct through the air. Any vibration set up in the structure of the aeroplane by the power plant is liable to cause resonant vibrations and rattles in the walls and fitments of the cabins. Thus engines and airscrews should be perfectly balanced to minimise vibrations. There is some evidence that, as judged by passengers in the cabin of an aeroplane, two engines attached to the wings are no noisier than one engine attached to the nose of the fuselage, although the latter is further away from the observers.

The Exclusion of Noise from Cabins.—Having considered the suppression of noise at the source, and the location of the sources as far from the cabin as possible, it remains to note the best type of cabin construction for excluding the residual noise from the passenger accommodation.

Wholly airborne sound can be excluded by the avoidance of open windows, of open apertures between the cabin and noisier parts of the machine, and of excessive cracks and gaps around doors. The latter point is of some importance, and it may perhaps be said as a guide that the combined area of cracks, gaps, ventilating inlets, &c., should not exceed one ten-thousandths of the total area of the enclosing surface of the cabin. As regards changing the air of a cabin with permanently closed windows, only a small collecting cowl inlet aperture is necessary to ensure adequate ventilation in flight, and naturally it should not be located in a noisy region.

Cabin walls consisting of one layer of doped canvas—such as were common in earlier craft—transmit the noise without any appreciable reduction, and indeed it was found that to obtain moderate soundproofing with a single thickness much heavier materials were necessary, weight proving to be the dominating factor. As a result of a search for a construction as light as possible, yet giving at least about 30 decibels reduction, it appears that cabin walls should be double, having an outer reflecting skin of metal—say, duralumin—and an inner lining of imitation leather, of plywood in small panels, or of other material. The interspace should be filled with a light fluffy material, such as "Kapok." The total weight of a satisfactory wall is about $\frac{3}{4}$ lb. to 1 lb. per square foot, the filler itself weighing about 0·2–0·4 lb. per square foot and working out, say, at about 10–20 lb. per passenger. The filler is essential since a double wall of this type, if unfilled, is often no better than one of the faces alone. In order that the insulating power of the windows should be consistent with such a wall they should be of $\frac{1}{16}$in. glass. This glass is rather heavy, so it is clear that the window area must be carefully planned to avoid windows of excessive size.

Absorption of Sound within Cabins.—Some mitigation (limited, however, to a few decibels) of the noise which gains entrance to a cabin may be achieved by the provision of upholstery and curtains, for these act as absorbents of sound, which would otherwise be reflected to and fro within the cabin.

Quality of British Engineering Products.

On February 24th, 1932, the British Chamber of Commerce in the Argentine Republic sent to the Federation of British Industries a long letter which was referred by the F.B.I. to the British Standards Institution for consideration. The substance of that letter—see THE ENGINEER, June 3rd, 1932, pages 615 and 619—was that the standard of quality of British engineering products was unnecessarily high for South American markets and was accompanied by equivalent high prices, which rendered competition with other countries difficult or impossible.

Owing to the necessity of carrying out careful inquiries, the B.S.I. was unable to send a reply to this letter to the British Chamber of Commerce in Buenos Aires until July 10th of this year, and it has only now been released for publication. This reply takes the form of two letters and a supplementary note, all of which are printed verbatim below. Further reference is made to this very important matter in a leading article to-day.

Dear Sir,—Your letter of February 24th, 1932, addressed to the Federation of British Industries, was referred to this Institution for reply in regard to the various technical questions raised therein.

It is desired to thank the Chamber of Commerce for a most useful communication and to say that this Institution greatly appreciates the spirit in which the problem has been approached.

The Engineering Divisional Council, recognising that your letter raised questions of very great importance to the British engineering export trade, gave instructions that it should be referred to the various Industry Committees of the Institution for consideration. The three Committees principally concerned were the Public Works, the Mechanical and the Electrical Industry Committees, and they, in turn, referred your letter to the appropriate Technical Committees for consideration. In addition, it was circulated to the various responsible trade organisations in this country, and inquiries as to the experience of certain British commercial agents elsewhere have also been made.

This procedure has necessarily taken a good deal of time, and the replies received have required much consideration in order to make it possible to give your Chamber of Commerce anything which could be looked upon as a general expression of opinion.

In reviewing the matter, it has been necessary for our Committees to consider, in detail, not only the basis of the present British Standards and general British practice, but also to consider carefully general British trade practices in cases where no national standards have as yet been evolved. It has, moreover, to be borne in mind that the Committees responsible for the preparation of British Standard Specifications have, as a general policy, incorporated in the specifications conditions which represent good general practice. That is to say, the specifications do not call for the highest class of material or practice except in a few special cases, but they exclude what is generally looked upon as doubtful material. In general, those responsible for the preparation of British Standard Specifications include responsible engineers and manufacturers who are used to looking at the various questions from a broad economic view point and not solely from the point of view of the actual purchase price of the machinery or product under consideration. In preparing British Standards, and certainly in the general practice of the larger British engineering and manufacturing firms, the economic importance of the export trade has therefore not been overlooked, but of necessity the conditions at home have played a dominant part.

The evidence collected, which is summarised below, would appear to indicate that on the whole there would be very much to be gained by purchasers making use of British Standards and practices. There would appear to be ample evidence to show that the reputation of British machinery has been built up on quality and durability, and that these characteristics have in the past proved effective from the point of view of sales. The British Standard in the engineering field has attained a reputation which, I am sure you will agree, ought not to be jeopardised unless there is overwhelming evidence to justify such a change in policy. We have before us evidence that whilst the salesman encounters difficulties in securing the first order, when once business has been secured the recognised superiority of the British Standard is then a substantial factor in obtaining future business.

Such recognised superiority in manufacture must obviously be of the greatest value to the British manufacturer, and any proposal which might lead to losing or even reducing that superiority would require to be considered with the greatest care and caution.

These general observations are not intended to imply that the criticisms offered by your Chamber of Commerce are not most helpful, but to remind you of the economic difficulties of accommodating modern manufacturing methods to the very diverse requirements of numerous markets.

Replying, therefore, to your letter by subjects in the order in which they have been propounded :—

Electric Generators and Motors.—The correspondent quoted, who states that the British Standard rating for industrial motors limits the temperature rise to 40 deg. Cent., whereas the American and German allow 50 deg. Cent., is correct. This, in fact, means that the British motor is 12–15 per cent. larger than the corresponding American or Continental machine. The question of bringing the British rating (40 deg.) down to the American and German rating (50 deg.) has been discussed for many years in this country and in numerous international meetings, but the great advantages of the British rating for motors for industrial purposes has always been maintained and would appear to have been established. The British motor has a very valuable overload capacity, which for industrial purposes has proved a most desirable feature, and we have secured evidence to show that Continental manufacturers export motors to compete with British motors rated on the British basis. On the other hand, there are a number of British electrical manufacturers who modify the rating when necessary to compete with American or German machines.

A more detailed reply in regard to electric motors is attached (see below).

Cranes, Derricks, Steel Structures, &c.—The Committees responsible for the British Standard Specifications for Cranes and Derricks desire to point out that the policy adopted in preparing these specifications has been to provide factors of safety no higher than is necessary to provide adequate security in operation, thus making provision for cranes as light in weight as possible, having due regard to the use of British Standard sections. Working to those standards, a crane built to the limits laid down in the specifications would, therefore, be the lightest possible, consistent with proper protection to those using it and those working in its immediate neighbourhood. The criticism of your Chamber, however, has raised the important point as to whether the existing British Standard sections might not have added to them certain other sections which would permit of the construction of cranes of adequate strength, but of lesser weight, and this point will be carefully reviewed both from the design as well as from the economic point of view.

Your Chamber's report as to the crane which permitted of the excessive overload named is difficult to deal with fully without some amplification, but it is clear to us that some cranes may have been supplied, for reasons which seemed adequate to the designer and manufacturer, which were somewhat heavier than the British Standards allow as a minimum.

With regard to the transporter bridge to which reference was made, we have ascertained that the English structure was designed to certain loads and conditions imposed by the authorities in the Argentine and does not contain an excessive amount of steel for those loads. We are not aware as to the conditions under which the German structure was designed, and in any event we are advised that neither of them would conform to good engineering practice, as the span is too short for a proper transporter bridge.

In regard to bridge design, British practice may be said to have been on a somewhat generous basis, in the light of modern experimental evidence, and the British Standard Specification is being revised to provide for higher stresses than formerly.

The same may be said to apply to building structures. The new British Standard Specification for Structural Steel for Use in Buildings permits of a possible saving of some 20 per cent. in weight of material over previous home practice. British practice has been to a certain extent dominated by the conditions laid down for structural work in London, where the safety of the public and of other buildings has been the primary consideration and no risks could be taken.

During recent years a large amount of knowledge has been accumulated, and experimental work is still being carried out on an extensive scale, and it is probable that further revisions in the standards may be brought about. It is, however, by no means certain that much further weight reductions will ensue. It can, however, be safely asserted that lightening the weights by manufacturers in other countries has been based to a certain extent on an absence of exact knowledge, a knowledge which in this country has been gained at great expense.

Oil Engines.—Your Chamber's comment that British oil engines are rated at an output which is under their maximum, whereas our competitors have no margin, is a condition which could not be corrected by any British Standard Specification. An international Committee is sitting discussing the basis for rating of oil engines, in which the British Committee is participating. The work of this international Committee will tend to diminish fictitious statements as to the capacity of oil engines. It is not anticipated that any of your associates would agree to the supply of an oil engine not capable of carrying continuously its rated output for twelve hours, and capable for periods of one hour of developing a load 10 per cent. above its rated output, without mechanical trouble. And that is the British rating.

Boilers.—In regard to boilers, your Chamber's attention is directed to the fact that British insurance rules for the design and construction of boilers compare very favourably with the American rules, but the Argentine rules for inspection of boilers specify a maximum life service at a particular steam pressure and temperature for every boiler, irrespective of its quality or condition. This rule is so obviously wrong technically as to suggest that the Argentine authorities might consider the preparation of rules for the construction of boilers so that quotations from different countries would be comparable. British Standard Specifications for the various types of boilers will shortly be available and these might be acceptable to the Argentine authorities.

Again, in this connection, whilst in the past it is probable that a good deal of inferior material has been supplied for export by manufacturing countries, it is believed that economic conditions are driving purchasers to take precautions to see that their money is being spent in the most efficient manner.

Refrigerating Compressors.—Your Chamber has gone into this matter in considerable detail and the British makers have been much interested in the views expressed. They point out that some of the points of difference referred to are due to comparing the monobloc twin-cylinder designs with British multi-cylinder designs. In the former, a centre bearing between the cranks is not admissible, because the monobloc cylinder centres are so close together that they do not allow for it. It may be remembered that the British system of independent cylinders is more convenient for spares, and that in the multi-cylinder British designs, bearings between the cranks are essential with more than two cylinders, and desirable in any case, in order to give longer life and smoother running. The complete machining of crank shafts is adopted to ensure accurate balancing at high speeds. The machining might be reduced if the demands were sufficient to warrant the preparation of a B.S. Specification which would in itself, if widely used, so co-ordinate the users' requirements as to justify the cost of the dies for drop-forged cranks for small machines.

British makers appear to favour a standard two-bearing motor for these compressors, on the grounds of quick delivery and better support for the fly-wheel, which they consider desirable.

Your Chamber's observations as to cutting out unnecessary material and labour, and also as to relative weights of British machines and those of other countries, have been studied with interest by British makers, and elicited detailed replies from them. It is not possible, in the compass of this letter, to set them out in detail, but it is claimed that the modern high-speed multi-cylinder machines of British construction would compare reasonably with the U.S.A. machines in weight, and that such difference as exists gives the British machines the advantages of better turning moment, more bearing surface, longer life, and smoother running.

Concrete Mixers and Road Machinery.—It is generally admitted that British road plant is heavier and better finished than foreign machinery, but the manufacturers in this country are unitedly of the opinion that customers in various parts of the world definitely expect a higher standard from British machinery and would be disappointed if they did not get it. The criticisms offered by your Chamber are being taken seriously into account by the British manufacturers, whose technical staff are reviewing the position. It is, however, pointed out that in general the American plant is bought in most cases just for the one job. The construction of the plant depends also on the rolled steel sections available. It would seem probable that, in the future, quotations based on plant of good quality but with less attention paid to finish will be available.

Motor Cars and Cycles.—This is a subject with which this Institution does not deal, the basis of the British horse-power rating being governed by legal statute for the purpose of taxation. It is probable that the remarkable fuel economy of the British car, and the improvement in the roads in all parts of the world, will tend to cause overseas purchasers to give preference to the British car, notwithstanding the anomalies of its rating.

Air Compressors.—The best-known British makers of air compressors have studied the comments of your Chamber. It is unfortunately true that the British manufacturer who quotes on cubic feet of free air delivered is at a disadvantage if an uninformed buyer accepts the piston displacement as the measure of the air delivered by an air compressor. Years ago British makers were compelled to fight against this practice, and have so far succeeded that they do not consider, except in quite small machines, that this is a regular practice to-day.

I am asked to point out that no purchaser would, for example, buy a steam engine or an oil engine on its piston displacement, and that it is the duty of salesmen to point out to the purchaser the obvious difference between displacement and the British makers' guarantee that the machine will actually deliver the volume of free air specified. It is considered that any return to the practice of quoting solely on piston displacement would be a retrograde and indefensible step, and that both users' and producers' interests would best be served by educating the buyer to insist on a guaranteed performance.

It would certainly be a wise step, at the present time, to give both the piston displacement and the guaranteed free air delivery, and, indeed, this is usually done. The expression "F.A.D." (free air delivered) is now being adopted in this country, and its definition is that it represents the "actual volume which the compressor will compress and deliver at the stated pressure expressed in cubic feet or cubic metres per minute at the intake and temperature and pressure." It is hoped that by persisting in the education of the buyer in this way the expression "F.A.D." will become as common and well known abroad as the expression "B.H.P." for prime movers.

Valves.—Whilst accepting the statement that the British flanges for valves and pipes are heavier and that the bolt holes are more numerous, in the case of some material delivered to customers in Buenos Aires a comparison of the British Standards and practice with the U.S. practice shows, almost throughout the whole range of flanges from low pressures up to the very highest pressures (1400 lb. per square inch), that the British flanges are smaller in diameter and lighter in weight. In general the number of bolt holes are the same, and, where different, the U.S. standards mentioned have generally larger bolt holes.

A detailed analysis is attached for the information of your Chamber.

General.—With regard to the suggestions for the adoption of the decimal system, and the relationship between the U.S. ton and the British ton, and your Chamber's proposals for the simplification of shipping documents, these have all been noted.

As a result in all British Standard Specifications the use of the pound as well as the ton is being incorporated. With regard to gallons, the difference will certainly also be made clear. It would seem that the U.S. gallon could with advantage disappear, as the British gallon so happily fits any decimal calculations.

In submitting this reply, which has been based on a large mass of information, there is a good deal of evidence to justify the broad contention that the British Standards of quality are higher than those of other countries. There is a good deal of evidence, on the other hand, to show that, whilst in the past low first cost may have been of prime importance, to-day more attention is being paid to the question of the real economic cost. Indeed, the cost of maintenance, breakdowns and repairs are becoming of greater importance and more generally recognised. This is an aspect to which I am specially desired to draw the attention of your Chamber.

It has to be remembered also that in many countries there is a growing practice of making rules and statutory regulations for the safety of workers and the public, which tend more and more to govern the construction of engineering equipment. There will therefore be an increasing tendency for British Standards of quality to be adopted in which this aspect of the matter has had a considerable influence.

The question of introducing into British Standard Specifications different grades of quality for home and export is not a policy which is viewed with any favour.

In thanking your Chamber for their most interesting and useful communication, my Institution desires me to invite your Chamber to take more direct advantage of the Local Committee of this Institution by appointing to it engineers familiar with and experienced in the industrial requirements of the Argentine. If they will then review the B.S. Specifications and transmit to us concrete proposals for any modifications which from their wide knowledge of local conditions would, in their opinion, tend to make these specifications more acceptable to purchasers in the Argentine, such proposals would, at once, be examined by the Technical Committee responsible for the particular specification under review.

The Committee would, in this way, have the great advantage of having before them specific suggestions for assisting British trade in the Argentine market and would have to consider these in the light of the demands of the home market and export markets other than the Argentine, having due regard to the economics of the situation.

The question would then be one as to whether the proposed modifications would be generally acceptable for all markets or whether they could only be applicable to the Argentine market and might have to be issued under the ægis of our Argentine Local Committee.

It is further suggested that every importer should be urged to call attention to the very valuable series of specifications issued by this Institution, copies of which are available at the offices of the Association of British Engineers in the Argentine and also at the offices of Mr. H. C. Siddeley, the local representative of the electrical manufacturers. (Signed) C. Le Maistre,
Director.

Dear Sir,—It is felt that your Chamber would be interested in a further inquiry which was undertaken by the Department of Overseas Trade in South Africa. The Department, after calling attention to some of the points which were made, sought the opinion of responsible organisations on the following four points :—

(*a*) Whether, for the purpose of that market, existing British Standard Specifications appear to involve an unnecessarily high standard of quality ;

(*b*) If so, how far this prejudices British manufacturers and exporters in competition with their foreign trade rivals ;

(*c*) To what extent the standard of quality hitherto observed in British machinery has created goodwill which is of commercial value in the market in question ;

(*d*) Whether the competitive power of the British industry would be increased by the provision of alternative British Standard Specifications, or additional grades in existing specifications, involving a lower standard of quality.

This inquiry went before the Electrical, Mechanical, and Chemical Committees of the South African Branch of the British Standards Institution and manufacturers' organisations, as well as the chief engineers of responsible public works, railways, harbours, &c., and the general consensus of opinion was that the present standards were most satisfactory and that they would deprecate a lowering of them except in the case of margins of safety applied to structural work in the British Standard Specifications, where in the past the maximum stress permitted has been 8 tons per square inch. It may interest you to know that in this particular case the Committee has already modified that figure in the light of the greater knowledge which exists to-day than when that figure was first adopted, and the British Standard Specification now allows for 9 tons instead of 8.

In all other respects the replies broadly supported the viewpoint very generally held that the standard set by the British Standard Specifications was a definite asset rather than a disadvantage in securing business in that market. (Signed) C. Le Maistre,
Director.

Electrical Generators and Motors.

The comment of the British Chamber of Commerce has reference to a correspondent's letter, which remarks :—

> "We invariably quote a 40 degree temperature rise for rotary gear, whereas the U.S.A. and the German rating is generally 50 degrees. The point, however, is lost when prices are compared, and no amount of talk would persuade an Argentine client that 40 degrees is better or necessary."

The Chamber further adds that unless a special industrial type is put forward and smaller frame sizes offered with higher temperature rise, it would be found that British goods are out of line.

It appears to have been overlooked that the motor or generator with a 40 deg. temperature rise is capable of withstanding an overload of 25 per cent. for two hours (except in the case of fractional horse-power motors), and that this overload is a fundamental part of the rating. This rating has been used in Great Britain since the first Standard Specification and is thoroughly understood. Moreover, it is preferred, after practical experience in this country of a rating without overload.

It is not, therefore, a question of putting forward smaller frame sizes with a higher temperature rise, but a question of understanding what the two ratings mean. If the two ratings are understood, without the slightest difficulty the appropriate size of motor can be selected for a given job whichever rating is selected by the purchaser.

The Chamber further remarks that British firms object to offering machines with higher temperature rises than 40 deg. Cent. This appears to have been written under a misapprehension, as we are assured by the leading British firms who stock motors in Buenos Aires that, although their motors are rated in accordance with the British Standard (*i.e.*, a 40 deg. rating with 25 per cent. overload for two hours), they are quite ready to sell machines with a corresponding 50 deg. maximum rating (the necessary factor to give this information is generally to be found on the rating plate, and is referred to in the British Standard Specification). This information also exists in their local offices in order that this may be done if desired by the customer.

It is largely a question of education and past experience whether a purchaser prefers a 50 deg. maximum rating or a 40 deg. load plus overload rating.

The 50 deg. continuous maximum rating was tried in this country some years ago, but never came into general use, owing to the fact that British engineers and designers, who had to apply the machines industrially, found a load-plus-overload rating enabled the motor to be used to the best advantage, as almost all motors have to give overloads at times.

It may be pointed out that the 25 per cent. overload is a somewhat higher figure than the corresponding 50 deg. maximum rating for that motor.

If, therefore, an agent in the Argentine has difficulty in selling a British Standard 40 deg. rise motor in competition with the foreign 50 deg. maximum rating motor made in another country, his obvious course is to ask the British manufacturer to turn his standard rating with 25 per cent. overload into a maximum rating with 50 deg. temperature rise.

Other comments in the communication from the Chamber suggest that British motors and generators are unnecessarily heavy for the purpose for which they are designed. It would be found on full examination that, although the British makers would be unwilling to adopt the light constructions which, it may be, are employed by certain foreign competitors, yet their machines do not contain waste material, and with regard to weight are comparable with the best class of foreign manufacture.

LAUNCHES AND TRIAL TRIPS.

Southern Cross, motor yacht ; built by Cammell Laird and Co., Ltd., to the order of the Melanesian Mission Trust (England), Ltd.; dimensions, 120ft. by 28ft. 6in. by 12ft. 6in. Oil engines, Gardner type ; trial trip, September 7th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Still Engine Company, Ltd., 10, Victoria-street, Westminster, London, S.W.1, announces that on September 5th it changed its designation to Diesel-Steam Locomotives, Ltd., in order to be more consistent with its present activities.

Following the resignation of Commander A. B. Watts and Mr. W. S. Flight from the board, Alfa-Laval Company, Ltd., announces the following appointments :—Mr. H. H. MacColl continues as chairman of the company ; Mr. J. A. Powell has been appointed general manager ; Mr. R. H. Dolton takes over control of the industrial side of the company's business ; Mr. H. Mackegg has been appointed chief representative of the marine side of the company's business ; Mr. J. M. Kennedy, of Newcastle, and Mr. John Taylor, of Liverpool, continue as the company's marine representatives in their respective areas.

Yarrow and Co., Ltd., Scotstoun, Glasgow, W.4. announce that three new directors have been appointed to the board, which now consists of : Sir Harold E. Yarrow, chairman and managing director ; Mr. W. W. Marriner ; Mr. W. E. Young ; Mr. A. L. Mellor, and Mr. W. Nithsdale. The three new members of the board, Mr. Young, Mr. Mellor, and Mr. Nithsdale, have all held responsible positions in the firm for many years. Mr. F. J. Shepherd continues to act as naval architect to the firm, and Mr. A. J. Stanyard, the secretary, is a director of the Yarrow Adriatic Shipyard, Ltd., Kraljevica, Yugoslavia.

CONTRACTS.

The British Thomson-Houston Company, Ltd., has received through Mather and Platt, Ltd., Manchester, and Candy Filter Company, Ltd., London, orders for electrical equipment for the Southport and District Water Board. The equipment consists of three 150 H.P. vertical-spindle, variable-speed A.C. commutator motors for driving bore-hole pumps, with contactor panels for each motor, and also a main sheet steel panel switchboard. In addition, there are a number of smaller motors for a variety of services. The whole of the electrical installation, including the erection and cabling work, and also the lighting for the station, is to be carried out by the B.T.H. Company.

CATALOGUES.

G. and J. Weir, Ltd., Cathcart, Glasgow, S.4.—Catalogue, Section 8, of pumps for the oil industry.

George Russell and Co., Ltd., Motherwell.—Particulars of the improved "Weddell's" sounding machine.

Renold and Coventry Chain Company, Ltd., Manchester. —1933 price list of products for industrial applications.

Ransomes and Rapier, Ltd., Ipswich.—Pamphlets on gang trolleys and the new type 3½ cubic yard excavators now made by the firm.

B.S.I. Report.—The British Standards Institution has issued its half-yearly handbook, price 1s., which includes the Report presented at the last annual general meeting, as well as the indexed list of current British Standard Specifications. The report on the activities of the three Divisions—Engineering, Building, and Chemical—provides interesting reading and shows the enormous amount of valuable work voluntarily carried out by the Institution's six hundred technical committees. The section devoted to lists of British Standard Specifications includes a numerical list, a list of the new specifications in course of preparation, and a complete subject index.

Revised Rules Applicable to Code Telegrams.—We have received from Imperial and International Communications, Ltd., of Electra House, Victoria Embankment, London, W.C.2, particulars of the revised rules applicable to code telegrams, which, as a result of the decisions reached at the recent International Telegraph Conference at Madrid, will come into force on January 1st, 1934. The ten-letter code system will be abolished and only code words not exceeding five letters will be employed. Various other regulations regarding the use of figures and groups of figures, along with full particulars of the proposed changes, are given in the revised rules.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Difficulties of International Trade.

Although the position of the British steel industry is better than it has been for some years, this is mainly due to the steady demand from the home market. Export trade is a shade more active than for some time, but exchange fluctuations, import quotas, and the control exercised in many countries over payments to foreign creditors makes this side of the business troublesome, and at times dangerous. The fluctuations of the exchange have also raised problems which some of the international steel trade organisations find difficult to solve. This week the International Railway Manufacturers' Association, in which all the important rail-producing countries, including Great Britain and America, are included, will meet. It is obvious that price-fixing arrangements between steel industries which have to work on a gold basis and those trading in currencies which fluctuate in value like sterling and the dollar, are not easily carried out in these days. In addition, the loss of the Dutch order for rails is likely to create feeling amongst members of the Cartel, although the firm which secured the order is outside that organisation. Consumers, of course, dislike rings of manufacturers, whether international or national, and, generally speaking, are not sorry for an excuse to place an order with outsiders. Another meeting which will take place this week is that of the Management Committee of the Cartel, which has to fix a quota for the fourth quarter of the year. The last quota was placed at 500,000 metric tons per month, and was based on a minimum total of exports of 6,000,000 tons per annum. The Cartel claims that the quota figures have proved near enough to actual deliveries to be a reasonable guide for the last quarter of the year, and it is not expected that the total will be altered. The quota is not a hard-and-fast figure but is intended to be a guide for the works. This attitude was taken up when it was found impossible to collect the fines due to the old Cartel which expired some time ago.

A New Iron Ore Field.

The arrival at Glasgow of a cargo of 8000 tons of iron ore from Sierra Leone marks the beginning of an interesting development in that Colony. The ore was consigned to Wm. Baird and Co., Ltd., of Glasgow. It is of a similar type to that obtained from the iron ore fields in India, and it is anticipated that the average analysis will be 57 per cent. iron in a dry state. It contains 0·04 per cent. of phosphorus and it is claimed that it is suitable for the manufacture of foundry or basic pig iron. The deposits were discovered in 1927 and since then a railway of 3ft. 6in. gauge, 52 miles in length, has been constructed to link Marampa, where the mines are situated, with Pepel, the nearest deep-water terminus. The loading installation was supplied by the Mitchell Conveyor and Transporter Company, Ltd., of London, and the plant is designed to load steamers at the rate of 2000 tons per hour. The railway is equipped with Garratt locomotives supplied by Beyer, Peacock and Co., Ltd., of Manchester, and wagons supplied by the Metropolitan-Cammell Carriage, Wagon and Finance Company. In November, 1930, the Colonial Development Advisory Committee recommended a loan against debentures up to £500,000. The Sierra Leone Development Company, Ltd., was registered on September 20th, 1930, to develop the property, with a capital of £600,000, of which £100,000 was issued as fully paid to the vendors who had carried out the exploration of the property and the survey of the railway. The ordinary capital has been subscribed privately and there will be no public issue of capital. Amongst the firms who have supplied plant and machinery are the Cleveland Bridge and Engineering Company, Ltd., Associated British Machine Tools, Ltd., Avonside Engine Company, Ltd., Robert Hudson, Ltd., Brown, Lennox and Co., Ltd., J. and E. Hall, Ltd., Mather and Platt, Ltd., F. Braby and Co., Ltd., Stewarts and Lloyds, Ltd., Edgar Allen and Co., Ltd., and Stothert and Pitt, Ltd.

The Pig Iron Market.

Anticipations seem general that the production of pig iron will have to be increased during the autumn. In most districts the demand, if it is not level with production, is slightly in excess of it, so that stocks are being gradually depleted, and as it is unlikely that the ironmasters will want their holdings to be reduced to a very low tonnage, the outlook for an expansion in production is favourable. On the North-East Coast stocks have been depleted, and the demand still appears to be growing. The foundries and the engineers in that district are busy, and during the past week or two extra plant has been put into operation. In addition, foreign inquiries for Cleveland foundry iron have increased of late, and it looks as though business with Scandinavian markets will develop on a satisfactory scale. Business in hematite iron also has expanded to an extent which has substantially reduced the stocks, although a considerable tonnage remains in the producers' hands. Although the quotation for hematite is still 59s. 6d. for No. 1 and 59s. for mixed numbers, there is a noticeable tendency for prices to harden. In the Midlands the demand is steady and a considerable tonnage of iron is passing into consumption which is not represented by new business, as a short while ago many consumers covered their needs for some time ahead. The light castings industry is active, whilst the general founders, who have experienced depressed conditions for some time, have much improved their position. The most cheerful feature of the situation, however, is the way in which specifications are coming to hand against contracts for foundry iron, which is an indication that most branches of the consuming trades are well employed. The demand for forge iron also appears to be growing, the quotation being 57s. 6d. for Northamptonshire brands and 61s. for Derbyshire, Lincolnshire and North Staffordshire iron. During the past week a fair amount of business was transacted in East Coast hematite, as well as in Welsh hematite iron, at 75s. 6d. d/d. Although the demand for Cleveland iron from Midland consumers is not on a heavy scale, for the time being, the price has stiffened. The quotation is now about 72s. 6d. d/d Midlands for No. 3 foundry. For some time past consumers in Yorkshire have bought only for current needs, but as the stocks in makers' hands are gradually declining, they are showing an inclination to abandon this policy. In Scotland business has also been rather limited, and large contracts have been scarce.

Finished Steel Materials.

The market for finished steel materials has developed some irregularity, possibly because the Continental makers appear to have made special efforts to secure business. Whilst their quotations for overseas destinations were advanced by several shillings, as a result of the fall in the sterling exchange, the quotations for the British market were kept unchanged last week and they continued to quote £6 9s. 6d. for small bars. This competition was particularly noticeable in the Midlands, but the amount of business taken by the Continent has been comparatively small. The British re-rollers in the Midland district quote £6 15s., and in some cases a number of the makers have asked £6 17s. 6d. There is little doubt, however, that if a big order were in question the re-rollers would make drastic cuts rather than let the business go to the Continent. This week rather more orders for structural steel have come from the engineering trades. Forward contracts from the constructional engineers, however, have been scarce. Business in strip is a feature of the market. Some of the British producers have had to extend their delivery dates, and it is probable that more transactions are taking place with Continental works in the shape of orders for strip than in any other kind of steel material. The busy conditions at the works on the North-East Coast have been maintained. The constructional steel departments are well employed and the demand from this quarter has provided a welcome amount of work for the steel makers. Some inquiries which have been placed on the market for new ships have raised hopes that even the shipbuilding department, which has been the weakest section of the North-East Coast industry, may shortly experience a revival. The Yorkshire steel industry is in a better position as regards orders than for some time, especially as regards strip, whilst the activity in the motor industry is resulting in a steady call for alloy steels. The works producing stainless steel are also experiencing active trading conditions. Business in South Wales has been rather quieter of late, but the situation in the tin-plate industry is so good that it gives an appearance of activity to other sections of the market. During August the production of tin-plates reached 103,000 tons, compared with 51,200 tons for the corresponding period of last year.

The Advance in Sheet Prices.

The action of the British sheet manufacturers in advancing their prices by 5s. per ton was not unexpected. For some time the black sheet departments of most of the works have been actively engaged. The demand has lasted throughout the summer and now that the autumn trade is setting in it looks like expanding still further. The galvanised sheet section of the industry until recently has been passing through a period of severe depression; but latterly business with India has improved, whilst South Africa has been taking fair quantities and general export trading also has increased. In addition the Argentine order for about 20,000 tons, which was recently distributed amongst the British works, has placed the industry in a good position. A number of works have temporarily withdrawn from the market, so that the advance was merely a logical outcome of the increased trade. The new quotations for sheets will be found overleaf.

Current Business.

Members of the International Rail Manufacturers' Association are perturbed by the loss of a contract for Holland for 11,000 tons to 12,000 tons of rails which has been taken by the Verinigte Konigs und Laurahutte Works, which are situated in Polish Silesia. The works in Europe which are outside the European Steel Cartel have, during the past month or two, proved a thorn in the flesh of the British as well as the Continental steel makers. Only a few weeks ago the Hungarian State Works obtained a contract for 8000 tons of steel piling for the Gebel Aulia Dam, which was referred to in these columns. An interesting feature of the latter contract is the fresh disclosure that Egyptian cement is to be used in the construction of the dam. So far as can be ascertained this is the first time that cement manufactured in Egypt has been used in an important public contract in the Sudan. Fears are entertained that competition from Continental sources may result in the loss of a valuable Iraq contract in connection with the Habbaniyah irrigation scheme, which will involve the construction of a dam and the use of 1000 to 1200 tons of steel piling. It is understood that preliminary tenders have already been called for, and that the lowest have been submitted by one British and one German firm. If the contract is lost to this country, it is probable that considerable feeling will be aroused, as it is felt that, as large sums of British money have been spent in Iraq, some return in the way of business of this description might be confidently expected. The Department of Overseas Trade announces that tenders are open for the following:—South Africa: Cape Town Electricity Department, fifty automatic street-lighting controllers, to be presented in Cape Town by November 29th. Johannesburg City Council, two single-phase, 1620 kVA transformers, ratio 6600/3300 volts, to be presented in Johannesburg by October 28th. India: Indian Stores Department, Engineering Section, three electric mining and shunting locomotives with fittings and accessories, to be presented in New Delhi by October 19th. Egypt: Egyptian Ministry of Communications, Aviation Department, supply and erection of two portable aeroplane hangars at Dekheila and Mersa Matruh aerodromes, to be presented in Cairo by November 1st. Canada: H.M. Trade Commissioner's Office at Winnipeg, a boat-building firm in Western Ontario wishes to receive particulars and prices from United Kingdom manufacturers of marine Diesel engines suitable for installation in launches.

Copper and Tin.

The copper market has not recovered from the lethargic conditions which ruled last week. Although, so far as values are concerned, the American price is divorced from the European quotation, copper consumers in all parts of the world are swayed by rumours of changes in the American industry and financial situation, and are disinclined to do more than cover their immediate requirements. The position seems to be the same in all European countries, and as a consequence the market has developed weakness and the sterling quotation has dropped back to £38 c.i.f. owing to absence of business. The American producers, however, have held their price at 9c. Unofficial American estimates give the world's stocks of refined copper on August 31st at 653,000 tons, a reduction of 20,000 tons compared with the end of July. The production of refined copper in August is placed at 82,500 tons compared with 71,800 tons in the previous month. American deliveries were 47,500 tons, against 52,900 tons in July, whilst the overseas deliveries were 55,000 tons, compared with 56,000 tons in the previous month. . . . The tin market has been featureless and prices have remained comparatively steady. Such movements as have occurred have usually been traceable to reports relating to the American position. Buying by consumers, either in America or on the Continent, has been confined to a few small parcels, and speculators have shown no interest in the market. In conditions such as these comparatively small buying or selling transactions have had a disproportionate effect upon prices. It was reported this week that an attempt was likely to be made by the International Committee to persuade the Cornish tin mines to reduce their production, but it seems scarcely likely that in the present state of the industry this course will be readily agreed to. It is estimated that the American deliveries this month will amount to 6000 to 7000 tons, and there are anticipations that the visible supply will be decreased by between 2000 and 3000 tons.

Developing the Uses of Copper.

The Copper Development Association, the formation of which was referred to on this page in the issue of May 12th, has been incorporated as a company with offices at Thames House, Millbank, London, S.W.1. The conduct of detailed business will be invested in a Management Committee, of which Mr. A. D. Storke is chairman, and on which most of the important copper interests, including the trade associations, will be represented. Mr. D. P. C. Neave, general manager and secretary, will shortly submit to the Management Committee recommendations regarding the staff required, and the general lines of work to be undertaken. The Association will have sufficient funds over a period of years to ensure progress in its objects. Contact has been established with the American Copper and Brass Research Association, and with the Copper Institute of Germany, with a view to the interchange of information. It is proposed for the present to concentrate upon the development and the extended uses of copper rather than research work. It has long been urged that the large increase in the production of copper during the last decade can only be adequately taken care of by discovering new uses for the metal, and the Association will devote its energies to this purpose.

Lead and Spelter.

There have been only slight fluctuations in lead prices this week. The demand from the consumer trades in this country has been poor since the end of August, but this was to be expected after the heavy buying which then took place. At that time large contracts were placed by the building and associated trades, with manufacturers of pipes and sheets, and the latter at once covered their forward requirements. Deliveries against these contracts are well maintained, and it is estimated that this section of the industry is producing at the rate of about 1500 tons per month. Buying by Continental consumers has been rather light. As a result the lead market has had a quiet appearance, but there is no doubt that a considerable quantity of lead is passing into consumption, and any revival of buying on the part of users would quickly be reflected in higher prices. . . . Steady, but rather listless conditions have marked the spelter market for the past week or two, and there are no indications of an early change. The statistical position appears sound, and although in August production was increased from 51,217 to 53,029 tons, the stocks in the hands of the members of the Cartel at the end of the month were reduced by 3114 tons to 121,288 tons. It is generally supposed that there are considerable stocks existing outside the Cartel, but this has not influenced the market. It is reported that the Silesian producers have sold their quota for some time ahead. On the whole, this market appears to be in a sound position, and the price is held at a reasonable level. Reports from the Continent state that the International Zinc Cartel has decided to dissolve on October 31st owing to difficulties which have developed with the Belgian smelters regarding the system of levying fines on excess production. Similar reports have circulated in the past, but it has always been found possible to reach an agreement.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	2 19 0	2 19 0
No. 1	2 19 6	2 19 6
Cleveland—	*(D/d Tees-side Area.)*	
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
Midlands—		
Staffs.—	*(Delivered to Black Country Station.)*	
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d.	10 0 0	9 0 0
21-G. to 24-G., d/d.	10 5 0	9 5 0
25-G. to 27-G., d/d.	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export; **£16 7s. 6d., c.i.f. duty paid India.**
„ **£11 5s. 0d., f.o.b. other markets.**
„ **Scandinavian Markets Free.**

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel ports, 16/9 to 17/–

Tin-plate bars, d/d South Wales works, £4 15s.

Billets.	£ s. d.
Basic Soft (25·41% C.)	5 15 0
„ Medium (0·42% to 0·60% C.)	6 12 6
„ Hard (0·61% to 0·85% C.)	7 2 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 25% C.), 500 tons and up	5 2 6
100 tons	5 10 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/– per lb.	
Ferro Tungsten	1/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 17 6	7/–
„ „ 6 p.c. to 8 p.c.	£19 7 6	7/–
„ „ 8 p.c. to 10 p.c.	£18 17 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£29 15 0	9/–
„ „ „ 1 p.c. carbon	£30 17 6	10/–
„ „ „ 0·70 p.c. carbon	£35 15 0	12/6
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon 45 p.c. to 50 p.c.	£12 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£18 2 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, September 27th.

Copper—		
Cash	£34 8 9 to £34 10 0	
Three months	£34 12 6 to £34 13 9	
Electrolytic	£37 15 0 to £38 5 0	
Best Selected Ingots, d/d Birmingham	£38 0 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
Brass—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£216 12 6 to £216 15 0	
Three months	£216 10 0 to £216 12 6	
Lead:	£11 17 6 to £12 1 3	
Spelter:	£16 13 9 to £16 17 6	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 13/–
„ Glasgow— Ell	13/6 to 13/9
„ „ Splint	14/6
Ayrshire—	
(f.o.b. Ports)—Steam	11/3 to 11/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/3 to 12/6
Unscreened Navigation	12/– to 12/6
Lothians—	
(f.o.b. Leith)—Hartley Prime	11/– to 11/6
Secondary Steam	10/6 to 10/9

ENGLAND.

Yorkshire—		
B.S.Y. Hard Steams		17/– to 19/6
Furnace Coke		11/– to 12/–
Northumberland—		
Best Steams		13/6 to 14/–
Second Steams		12/6 to 13/–
Steam Smalls		8/6
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/6
Foundry Coke		16/6 to 17/6
Sheffield—	Inland.	
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	8/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Second Smokeless Large	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	17/9 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	19/– to 36/–
Furnace Coke	15/– to 17/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	10/– to 11/–
Steam Coals:	
Large	18/– to 20/6
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3⅛d.
Diesel Oil	3⅜d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Exporting Industries.

The trade policy of France is divided by two entirely opposed factors, one being the interests of agriculturists who claim the fullest measure of protection, and are obtaining it, and the other the exporting industries, which are suffering from the effects of the import quotas and other restrictions, imposed mainly for the benefit of agriculture. There are also new industries that cannot exist without these import restrictions. The exporting industries are strongly grouped, and having, as they believe, failed in their efforts to impress upon the Government the necessity for providing facilities to trade with other countries, they have joined up with the maritime Chambers of Commerce, the ports and other bodies interested in foreign trade expansion in making a collective appeal to the Prime Minister for the immediate solution of a problem that threatens the country's economic existence. This appeal is the most serious and emphatic in tone of any yet made. It points to the rapid decline of the export trade and the increasing cost of production, to the extent that manufacturers depending on foreign business have now, it is said, reached the limit of their ability to keep works in operation. Unless something is done immediately to provide facilities for an interchange of goods with other countries, they will, it is urged, be obliged to close down, and 2,000,000 workpeople will become idle. The appeal asks for an early interview with the Prime Minister in order to obtain from him a definite statement upon the Government's economic policy.

Engineering Trades.

There is some hope that the constructive and mechanical engineering industries will pass through the coming winter without suffering too much from the general inactivity. The public works programme, however, does not seem to be near realisation, and it is now proposed to prepare a new one, but it is difficult to see how anything can be done to finance these works until the Government is assured of balancing the Budget. Nevertheless, the railway companies are expected shortly to distribute orders for rolling stock, and there are some important municipal undertakings to be put in hand, such as the construction of the pumping stations, aqueduct, and reservoirs for the supply of water from the Vals de Loire to Paris, while it is announced that a ship is to be put on the stocks to replace the "Atlantique." Notwithstanding complaints of a slump in the building trades, some activity is observable, and a certain amount of structural steel is going into consumption. The reconstruction of the Carrousel Bridge across the Seine in Paris has been officially authorised. The existing cast iron bridge was built in 1834, and is now condemned as being inadequate for the traffic, while the design is criticised as lacking in artistic harmony, and it has the drawback of not being in line with the passage from the Louvre. The new bridge will be of reinforced concrete, and will have a width of about 100ft. The road between the Louvre and the Seine will pass under that carrying the traffic through the Louvre passage to the bridge.

Compagnie Generale Transatlantique.

The terms under which the Compagnie Générale Transatlantique is to be refloated have been approved by the shareholders, who have consented to wiping out the existing capital by replacing the shares with bonds entitling holders to certain dividends and a participation in surplus profits, if any. The shares held by the State are not, however, to be converted in this way, and will serve to increase the State holding and insure for it a direct control over the company's affairs. The new capital has been fixed at 218,477,000f., and there will be a public loan issue of 150,000,000f. The estimated value of the shipping owned by the company has been reduced to 1057 million francs. The buildings and all assets have been heavily depreciated. The company's losses for the past three years are shown in the balance sheet just published to have totalled 593,488,869f. Last year fifty-two ships, totalling 272,858 tons, were laid up, most of them being old vessels. Since the reconstruction of the company satisfactory progress has been made with the organisation of the services, particularly in the more economical and efficient running of lines other than the Transatlantic, and three additional ships have recently been put on the active list. Meanwhile work continues on the "Normandie," so that she can start on her maiden voyage in the spring of 1935.

A Deep Artesian Well.

It is just a century since the first artesian well was sunk in Paris, and for a long time afterwards artesian well boring provided a succession of disappointments and disasters, through want of experience in dealing with a particularly delicate operation. The sinking of a well 880 yards deep at Aulnay-sous-Bois, a north-eastern suburb of Paris, may therefore be regarded as a centenary event. The water underlying the Paris region is an infiltration from a vast subterranean supply extending from the Ardennes to the Massif Central, but knowledge of the geological formation at these depths still lacks precision, so that when a company undertook to guarantee a supply of 5000 cubic metres of water a day, and expected, on the strength of the geological plans available, to obtain water at a depth of 656 yards, the necessity of going 230 yards deeper was another disappointment to the well-borer, who was working under a fixed contract. The boring began just three months ago with a diameter of 40 cm., and as the bore had to be carried down to the water supply before inserting the 30 cm. tube, the work had to be accomplished with great precision. As the boring proceeded, clay was injected around the walls under air pressure. On Saturday last the work of lowering the tubes was successfully accomplished. There were forty-two tubes, each 20 m. long. The water has a temperature of 34 deg. Cent., and will be cooled by mixing with water at 14 deg. obtained from other wells at much smaller depths.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

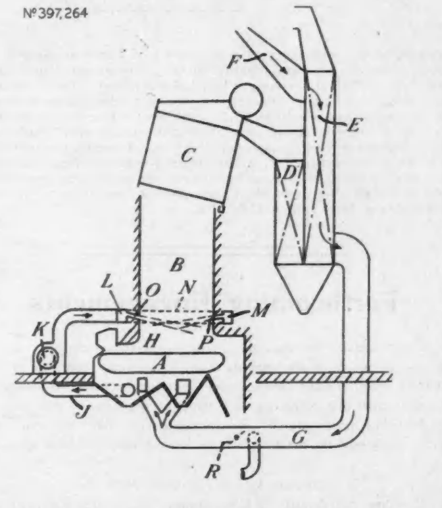
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

397,264. May 19th, 1932.—Improvements Connected with the Combustion of Fuels in Furnaces, Babcock and Wilcox, Ltd., Babcock House, Farringdon-street, London, E.C.4; and B. Samuels.

Under certain conditions with mechanical grates a great quantity of small particles of ash and incompletely burned fuel is thrown off the grate and becomes entrained in the gases sweeping up through the combustion chamber towards the boiler. These particles, on reaching the boiler tubes, cause clogging of the gas spaces and increase the frequency with which cleaning becomes necessary. In addition, a loss in efficiency is involved. In order to overcome this trouble the inventors provide downwardly inclined nozzles extending from boxes disposed in opposed walls of the combustion chamber providing downwardly directly opposed streams of relatively high-pressure air or gas forming a screen of air or gas or a mixture thereof across the furnace by which the grits and fly ash entrained in the gases passing up the combustion chamber are projected back on the grate. In the diagram A denotes the mechanical grate installed in a combustion chamber B under a boiler C, D denotes the economiser. E the air heater, and F the air inlet leading to the air heater E, Normally in a steam generating unit of this kind the gases of combustion rise up through the chamber B and pass through the tube bank of the boiler, whence they are carried downwards through the economiser D and upwards to the chimney or by induced draught fans through the air heater E. The air required for combustion is introduced under pressure at F and passed through the air heater E, being carried to the stoker by a duct G which introduces the air below the mechanical grate A. In the embodiment illustrated the lower air box is connected by a duct J with a blower K by which a part of the air delivered is drawn off from the air box and is passed through the blower K which delivers the air under pressure to boxes L, M, and N situated, for example, in the rear, front, and side walls of the combustion chamber. These boxes L, M, and N are arranged with nozzles O and P passing through the walls, which project air across the furnace as indicated so as to form a screen preventing ash and/or incompletely burned fuel passing in an upward direction among the tubes C of the boiler. The nozzles direct the air in a downwardly inclined direction, which causes the particles to return to the rear portion of the grate A, whence they pass to the ash pit.—*August 24th*, 1933.

Nº397,264

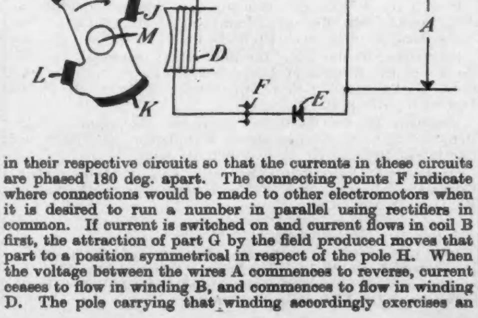


DYNAMOS AND MOTORS.

396,855. March 21st, 1932.—Electromotors, Siemens Brothers and Co., Ltd., of Caxton House, Tothill-street, London, S.W.1, and Horace Edgar Humphries, of 61, Rochester-way, Blackheath, London, S.E.3.

A motor constructed in accordance with this invention is suitable for use on a single-phase supply system. The alternating current supply is connected to wires A. The winding B is connected to these wires through a rectifier C and winding D through a rectifier E. The rectifiers may be of the dry plate type, such as the copper-copper oxide type. The rectifiers are connected in their respective circuits so that the currents in these circuits are phased 180 deg. apart. The connecting points F indicate where connections would be made to other electromotors when it is desired to run a number in parallel using rectifiers in common. If current is switched on and current flows in coil B first, the attraction of part G by the field produced moves that part to a position symmetrical in respect of the pole H. When the voltage between the wires A commences to reverse, current ceases to flow in winding B, and commences to flow in winding D. The pole carrying that winding accordingly exercises an attraction on the broad face presented by J, which is now close to the pole as compared with the edge of K The armature is accordingly turned in a clockwise direction and eventually the part G comes opposite to the pole. The next reversal of voltage causes current to flow in winding B, and an attraction is exerted on part L and K eventually comes opposite the face of pole H. The magnetic circuit is completed through the armature spindle M and a yoke in which the spindle is centred the yoke carrying the poles. Unwound poles may, however, be placed opposite to, *i.e.*, 180 deg. apart from, poles shown, separate yokes connecting opposite poles, or a common yoke connecting all poles.—*August 17th*, 1933.

Nº396,855

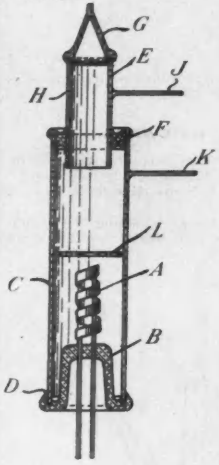


ELECTRICAL APPLIANCES.

396,998. December 16th, 1932.—Electron Discharge Devices, *Igranic Electric Company, Ltd., of* 147, *Queen Victoria-street, E.C.4.*

This invention is particularly applicable to gaseous electron discharge tubes. An electron tube which may contain, for instance, mercury vapour, has a filamentary cathode A, which is illustrated as a spiral conductor. The leading-in wires for the cathode A are embodied in a conventional seal B of glass or other refractory material. Surrounding the cathode and forming the major part of the outer enclosure of the evacuated space is a grid C in the form of a suitable metal cylinder. The grid is joined to the seal B at D in any approved manner. Mounted at the end of the grid opposite to that at which the cathode is mounted is a cylindrical metallic anode E, which is joined to the grid by means of a seal F. The cylindrical anode projects slightly beyond the seal F into the grid C, and outward beyond the seal F to form a part of the outer envelope of the evacuated space. A third seal G joined to the cylindrical anode H serves as a conduit for exhausting the vessel and is sealed off after exhaustion. It is, however, possible to seal off the vessel by closing the end of the anode by welding or other suitable means. The anode and the grid are provided with terminal wires J and K respectively. The grid is divided longitudinally into two compartments by means of a metallic partition L, which divides it into two halves except for a relatively small opening through which the discharge current between the cathode and anode may pass. A tube constructed in this manner showed much superior control characteristics as compared with the tubes without the partition.—*August 17th*, 1933.

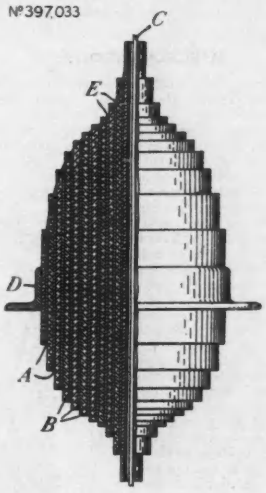
Nº396,998



397,033. February 20th, 1933.—Electrically Insulating Bushings, *Westinghouse Electric and Manufacturing Company, of East Pittsburg, Pennsylvania, U.S.A.*

This invention relates to electrically insulating bushings and particularly to outlet bushings of the condenser type for electrical apparatus, such as transformers and circuit breakers. Conducting cylinders A and dielectric cylinders B are arranged in the form of a multi-layer condenser, through which a line terminal or conductor C extends and about which an earth terminal or support D is disposed. The conducting cylinders A, preferably of relatively thin sheet material, such as lead or aluminium foil, are of decreasing lengths from the inner to the outer cylinder, so that the values of capacitance between adjacent cylinders are substantially the same. This construction provides the bushing with an intermediate cylindrical longitudinal section and tapered end sections. The length of the steps, defined by the ends of the cylinders, and the slope of the taper, depend upon the voltages involved, and the media in which the ends of the bushing are disposed. For instance, for a given voltage rating, if the bushing is disposed entirely in one dielectric medium, the end sections are preferably duplicates, whereas, if the upper end is for disposition in air and the lower end for immersion in oil, as is usually the case, the length of the upper section is preferably in accordance with the breakdown characteristics of air and the lower section of shorter length in accordance with the increased breakdown strength of the oil. Corresponding points on the upper ends of the conducting cylinders A define a curve E, which, in accordance with the invention, is a substantial reverse curve.—*August 17th*, 1933.

Nº397,033

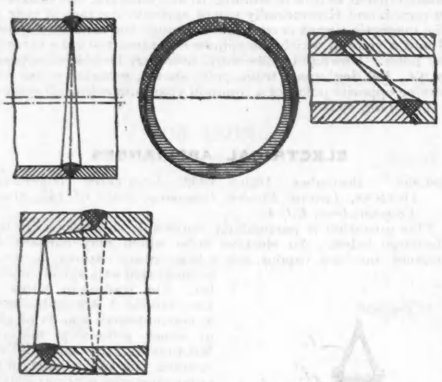


WELDING.

397,440. May 8th, 1933.—Welding Pipe Joints, E. Otto Dietrich Rohrleitungsbau Aktiengesellschaft, 2, Leopoldstrasse, Bitterfeld, Germany.

In autogenously welding together *in situ* of pipe lengths it is difficult to deposit sufficient metal on the underside of the pipe—that is to say, for the overhead weld—without making several passes. The inventors suggest, as an alternative, that, in such pipes as can be worked upon both from the inside and the outside, the weld should be made comparatively slight below and should be filled in with a deep welding from above. It is recommended that the transition from one part to another should be gradual. Several alternative joints are illustrated.—*August 24th*, 1933.

Nº397,440

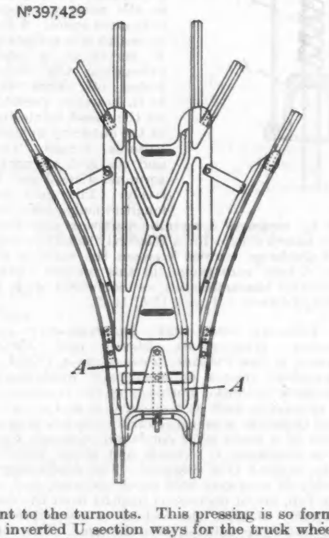


TRAMWAYS AND RAILWAYS.

397,429. April 11th, 1933.—Three-way Switches for Portable Light Railways, A. Faure, 12, Rue Verdié, Fermini (Loire), France, and A. Faure, Rue de la Loire 8, Fermini.

For the purposes of deflecting trucks to sidings on a contractor's light railway a steel pressing is placed over the main line adjacent to the turnouts. This pressing is so formed that it provides inverted U section ways for the truck wheels in all three directions, and has ramps which lead down to the normal rail level. There are tongue points at A A which may be used to deflect the trucks to either side track. These points are interconnected to prevent derailments.—*August 24th*, 1933.

Nº397,429

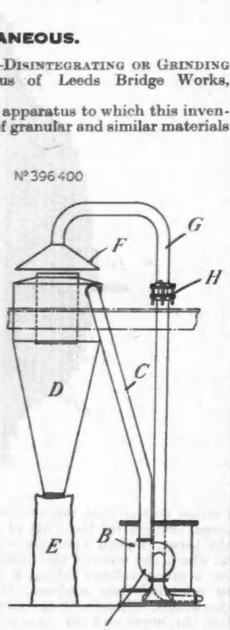


MISCELLANEOUS.

396,400. February 2nd, 1932.—Disintegrating or Grinding Apparatus, George Porteus of Leeds Bridge Works, Hunslet-lane, Leeds.

The disintegrating or grinding apparatus to which this invention applies is for the treatment of granular and similar materials and of the kind in which the disintegrator or grinder has a fan, and which delivers dust-laden air from the grinding chamber to a cyclonic dust separator or collector. With this kind of apparatus it is found that the air which escapes from the cyclonic separator or collector is not entirely free from dust, and the object of the invention is to overcome this trouble. A separate fan A is directly coupled to the rotary beater shaft of the grinder B and withdraws the ground material and dust at the discharge outlet of the grinder and elevates it by way of duct C to the upper end of a combined cyclonic settling chamber and discharge hopper D. Here the ground material falls to the bottom for delivery into bags at E, whilst the dust-laden air is drawn oft by way of a hood or canopy F in which a suction is maintained through a pipe G connected to the discharge outlet of the grinder B or otherwise so as to have suction induced therein by the action of the fan A or by the action of the grinder beaters. In order to provide for adjusting the hood or canopy F toward or away from the air outlet of the settling chamber so as to ensure that any dust from the outlet will be conducted back to the suction side of the fan and will not escape to atmosphere, the pipe G has a telescopic joint H whereby the hood may be moved up and down as desired.—*August 2nd*, 1933.

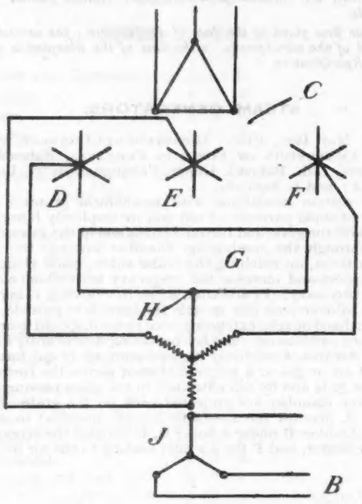
Nº396400



396,954. September 26th, 1932.—Frequency Transformation of Three-phase Current, Aktiengesellschaft Brown, Boveri and Co., of Baden, Switzerland.

A scheme is described in this specification for changing the frequency of three-phase current by means of multi-anode grid controlled rectifiers. In the diagram the feeding network of the frequency f_1 is shown at A, and the fed network of the frequency f_2 at B. The transformer C of the feeding network A is provided with three electrically separated secondary windings, D, E, F, each of which has six phases and is star-connected. To the secondary terminals of the transformer are connected the anodes of the rectifier G, which are so controlled by grids that a polyphase current of the frequency f_2 flows between its cathode H and the star points of the windings D, E, F. This polyphase current passes through the primary phase windings of the transformer J, the secondary winding of which feeds the network B. The secondary windings of the transformer C may consist of six winding sections instead of three as shown, in which case the primary winding of the transformer J will have six phases, the fed network B being three-phase. For obtaining a sine-like current of the low-frequency f_2 the phase voltages of the secondary windings D, E, F of the feeding transformer C may be of different magnitude. The grid control may be effected by commutator or by a grid transformer. According to whether the frequency ratio $f_1 : f_2$ is kept rigidly constant or is variable the commutator is driven synchronously with the frequency (f_1) of the feeding network A, or with the frequency (f_2) of the fed network B.—*August 17th*, 1933.

Nº396,954



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Saturday, September 30th.

Manchester Assoc. of Engineers.—Visit to works of Henry Simon, Ltd., Cheadle Heath. 2.15 p.m.

Monday, October 2nd.

Bradford Engineering Society.—Technical College, Bradford. Presidential address, "Modern Roads and Road Transport," Mr. H. Akeroyd. 7.30 p.m.

Inst. of Production Engineers: Sheffield Section.—At Royal Victoria Station Hotel, Sheffield. "Post Mortem Examinations (Metallurgy)," Mr. G. Howarth. 7.30 p.m.

Soc. of Engineers.—At Geological Society, Burlington House, W.1. "New Automatic Radial Sluice Gate," Mr. F. E. H. Shenton. 6 p.m.

Tuesday, October 3rd.

Inst. of Automobile Engineers.—At Royal Society of Arts, John-street, Adelphi, W.C.2. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.45 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—Elmbank-crescent, Glasgow. Presidential Address, Professor J. D. Cormack.

Inst. of Heating and Ventilating Engineers.—At Home Office Industrial Museum, Horseferry-road, Westminster, S.W.1. Annual general meeting. "The Trapping and Utilisation of Condensation," Mr. Alan G. Royle. 6.45 p.m.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. Presidential address. 6 p.m.

Inst. of Production Engineers: Eastern Counties Section.—At Lecture Hall, Public Library, Ipswich. "Die Casting," Mr. C. Vaughan. 7.30 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Age-hardening in Non-ferrous Alloys," Dr. L. Aitchison. 7.30 p.m.

Staffordshire Iron and Steel Inst.—At James Watt Memorial Inst., Gt. Charles-street, Birmingham. Presidential address, Mr. H. E. Cookson. 7 p.m.

Wednesday to Saturday, October 4th to October 14th.

Institute of Patentees.—Central Hall, Westminster, S.W.1. Ninth International Exhibition of Inventions. Daily.

Thursday, October 5th.

Inst. of Automobile Engineers.—At Merchant Venturers' Technical College, Bristol. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7 p.m.

Institute of Metals: Birmingham Local Section.—In the James Watt Memorial Institute, Birmingham. "The X-ray Analysis of Metals," Dr. V. E. Pullin. 7 p.m.

Institute of Metals: London Local Section.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. Chairman's address, Mr. S. L. Archbutt. 7.30 p.m.

Midland Metallurgical Societies.—At James Watt Memorial Inst., Gt. Charles-street, Birmingham. "The X-ray Analysis of Metals," Dr. V. E. Pullin. 7 p.m.

Stephenson Locomotive Society.—No. 1, Dining Club, King's Cross Station, N.1. "The Railways of South Wales," Mr. D. S. Barrie. 6.30 p.m.

Friday, October 6th.

Inst. of Chemical Engineers.—In Rooms of Chemical Soc., Burlington House, W.1. "The Sedimentation of Fine Particles in Liquids: A Survey of Theory and Practice," Mr. R. F. Stewart and Dr. E. J. Roberts. 6 p.m.

Institution of Sanitary Engineers.—Caxton House (Hill's Restaurant), Tothill-street, Westminster, S.W.1. Opening sessional meeting. Reception, 7.30 p.m.; music and dancing, 8 p.m. until 11.30 p.m.

Inst. of Production Engineers: London Section.—At Council Room, Soc. of Motor Manufacturers and Traders, 83, Pall Mall, S.W.1. "Jig and Tool Design," Mr. E. J. H. Jones. 7.30 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Education with Particular Reference to the Engineer," Mr. K. W. Willans. 7.30 p.m.

Physical Society.—At Royal Institution, 21, Albemarle-street, W.1. Council meeting, 4 p.m.; extraordinary general meeting, 5.30 p.m. Thomas Young Oration, "Thomas Young and the Simplification of the Artist's Palette," Dr. Herbert E. Ives. 5.45 p.m.

Railway Club.—57, Fetter-lane, E.C.4. "Permanent Way," Mr. W. A. Willox. 7.30 p.m.

Sir John Cass Technical Institute.—Inaugural meeting. Presentations to students. Address by Sir Robert A. Johnson, K.B.E. 8.15 p.m.

Saturday, October 7th.

Inst. of British Foundrymen: Lancashire.—Engineers' Club, Albert-square, Manchester. Presidential address, "Manufacture of the Mammoth Cunard Castings," Mr. F. Swift. 3.45 p.m.

Tuesday, October 10th.

Inst. of Automobile Engineers.—At King's Head Hotel, Coventry. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of British Foundrymen: Burnley Section.—Municipal College, Ormerod-road, Burnley. "Foundry Essentials and Incidentals," Mr. F. Whitehouse. 7.15 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Properties of Austenitic Steels," Dr. L. B. Pfeil. 7.30 p.m.

Wednesday, October 11th.

Television Soc.—At University College, Gower-street, W.C.1. "Television at the 1933 Berlin Radio Exhibition," Mr. E. H. Traub. 7 p.m.

Thursday, October 12th.

Diesel Engine Users Assoc.—Joint meeting with Inst. of Chemical Engineers, Caxton Hall, S.W.1. "Treatment of Cooling Water for Diesel Engines," Mr. L. O. Newton. 3 p.m.

Inst. of Marine Engineers: Junior Section.—85–88, The Minories, E.C.3. "'Two Milestones' in Workshop Practice," Mr. G. J. Wells. 7 p.m.

Royal Aeronautical Society.—At Royal Society of Arts, John-street, Adelphi, W.C.2. "Air Traffic Control," Major R. H. S. Mealing. 6.30 p.m.

Soc. of Chemical Industry.—At the Chemical Society, Burlington House, W.1. "Canning Fruit and Vegetables," Mr. G. Cadbury. 8 p.m.

Friday, October 13th.

Inst. of Engineers and Shipbuilders in Scotland.—Grosvenor Restaurant, Glasgow. "James Watt" dinner.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "The Influence of Harmonics in Transformer Circuits," Mr. E. Ambrose. 7.30 p.m.

Saturday, October 14th.

Inst. of Marine Engineers: Junior Section.—85–88, The Minories, E.C.3. Social and dance. 7.30 to 11.15 p.m.

Monday, October 16th.

Bradford Engineering Soc.—Joint meeting with the Technical College, at the Technical College, Bradford. "Degreasing of Metals," Mr. H. O. Brown. 7.30 p.m.

Tuesday, October 17th.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. "Oil from Coal," Dr. W. R. Ormandy and Dr. J. Burns. 6 p.m.

Sheffield Metallurgical Soc.—198, West-street, Sheffield. "Exhaust Valve Failures," Mr. C. C. Hodgson. 7.30 p.m.

Wednesday, October 18th.

Inst. of Fuel.—At Geological Society's Rooms, Burlington House, W.1. "Recent Developments in Coking Practice," Dr.-Ing. H. Koppers. 2.30 p.m.

Inst. of Fuel.—Connaught Rooms, Great Queen-street, W.C.2. Annual dinner and dance. Presentation of the Melchett Medal to Sir John Cadman. 6.45 for 7.15 p.m.

Friday, October 20th.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1 Informal meeting; election of Sub-committee. 7 p.m.

Inst. of Sanitary Engineers.—At Caxton Hall, Westminster, S.W.1. "Aggregates for Concrete Work," Dr. Bernard H. Knight. 6 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. Annual general meeting. Address by the President, Mr. R. J. Walker; cinematograph film, "Mechanism of Ships' Wake," Professor T. B. Abell.

Saturday, October 21st.

Inst. of Mechanical Engineers: Graduates.—Visit to the de Havilland Aircraft Company, Stag-lane Aerodrome, Edgware.

Tuesday, October 24th.

Inst. of Automobile Engineers.—At Hotel Victoria, Wolverhampton. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Sheffield Metallurgical Soc.—198, West-street, Sheffield. "Our Knowledge of the Conditions in the Blast-furnace," Mr. R. C. Tucker. 7.30 p.m.

Thursday, October 26th.

Inst. of Electrical Engineers.—Savoy-place, W.C.2. Presidential address, Mr. P. V. Hunter. 6 p.m.

Inst. of Mechanical Engineers.—At Dorchester Hotel, Park-lane, W.1. Annual dinner, 6.45 for 7.15 p.m.

Friday, October 27th.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. General meeting. Presidential address, Mr. Alan E. L. Chorlton. 6 p.m.

Saturday, October 28th.

Stephenson Locomotive Society.—Visit to Stratford, L.N.E. Railway Running Sheds. 2.30 p.m.

Monday, October 30th.

Bradford Engineering Soc.—Technical College, Bradford. "Salvage Work on the Ex-German Fleet at Scapa Flow," Mr. E. F. Cox. 7.30 p.m.

Inst. of Automobile Engineers.—At 39, Elmbank-crescent, Glasgow. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Stainless Steels," Mr. F. J. Murdoch. 6.45 p.m.

Tuesday, October 31st.

Inst. of Transport.—15, Savoy-street, W.C.2. Discussion, "The Duties of a Modern Transport Manager," Mr. M. F. Barnard.

A Seven-Day Journal

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A 66 kV. Switchgear Contract.

An important contract for 66-kV switchgear for the new power station of the Fulham Borough Council has been placed with the Metropolitan-Vickers Electrical Company, of Trafford Park, Manchester. It will be designed to meet the specification prepared by the Council's consulting engineers, Messrs. Preece, Cardew and Rider, and Mr. A. J. Fuller, who is the Borough Electrical Engineer. The order comprises three main sections, each containing one alternator equipment, a reactor outfit, and four feeder equipments. A transfer reactor equipment and neutral earthing gear are also being supplied. When inspection is necessary, the breakers will be lifted vertically from their oil-immersed isolating contacts, and a travelling crane will be provided for each section for taking the breakers to the unloading and inspection bay, which will run across the end of each switch house. All the bus-bar connections will consist of paper-insulated conductors of the condenser type, with earthed metal armourings. Duplicate circuit breakers are being supplied for both the alternator and feeder circuits, and each breaker will be fitted with the Metrovick cross-jet explosion pot contacts designed to interrupt a short circuit of 1,500,000 kVA. Each main switchgear section will control a 75,000-kW turbo-alternator set, two of which are at present in the course of manufacture in the Metropolitan-Vickers Electrical Company's works. The control board, which will be of the vertical cubicle type, with an automatic circuit indicating diagram, will be erected in a room between the switch house and turbine-room, and an additional board of the desk type will be provided for the control of the alternators. The value of the contract is approximately £297,000.

Oil from Coal.

Large orders, we are officially informed, have been recently received by the Parkhead Forge of William Beardmore and Co., Ltd., from Imperial Chemical Industries, Ltd., for forgings required for the plant which the company is erecting at Billingham-on-Tees for the production of oil from coal by the hydrogenation process. It will be recalled that it was recently announced in our issue of September 22nd that orders for large forgings required in connection with this plant had been placed in the Sheffield district. It is gratifying to learn that Scotland is also participating in the employment which will be created by this Government-supported scheme. It is further understood that, at the invitation of Imperial Chemical Industries, Ltd., the technical staff of William Beardmore and Co., Ltd., has been in close collaboration with the technical staff of the English Steel Corporation and Thomas Firth and John Brown, Ltd., in connection with the orders for these large and special forgings, which have now been placed by Imperial Chemical Industries in Sheffield and Glasgow.

The Gasification of Towns' Refuse.

On Thursday, September 28th, an official visit of inspection was made to Burnley to see a new type of gas producer plant for town's refuse, which has been supplied to the Corporation of Burnley by Whitfield Gas Producers, Ltd., of 82, Victoria-street, London, S.W.1. The plant is at present dealing with about one-third of the refuse of the town, and the gas supplied is being utilised to raise steam in a Lancashire type boiler. As the Burnley destructor station is adjacent to the electricity station, consideration is now being given to the possibility, subject to the permission of the Electricity Commissioners and the Ministry of Health, of the production of electrical energy with gas engine driven plant. The principal features of the new Whitfield design include a system of low-pressure air supply over the whole of the multi-compartment grate to the layers of fuel immediately above the grate and enables a reduced depth of fuel to be used. There is also a marked absence of excess air in the upper parts of the producer, which prevents the burning of the gas. A volumetric analysis of the gas produced shows a content by volume of 10·2 per cent. of carbon dioxide, 0·4 per cent. of oxygen, 48·2 per cent. of nitrogen, 40 per cent. of carbon monoxide and hydrogen, and 1·2 per cent. of hydrocarbons, while an average recorded calorific value of the gas produced is 132·1 B.Th.U. per cubic foot gross, with an outlet temperature of 85·6 deg. Fah. Some interesting figures have been prepared by the borough engineer and surveyor, Mr. Arthur Race, for a plant designed to deal with the whole of the refuse of Burnley.

The Retirement of Mr. K. S. Murray.

We are informed by the British Oxygen Company, Ltd., that Mr. K. S. Murray, M.I. Mech. E., the chairman and managing director of the company has signified his intention of resigning these positions at the end of December next. Although Mr. Murray has contemplated this step for some years, he delayed taking it until the reorganisation of the business, necessitated by its various amalgamations, had been completed. Subject to the approval of the shareholders at the next annual general meeting, Mr. Murray has been appointed honorary governor for life, in recognition of his invaluable services to the company, which have extended over a period of close upon fifty years. He has also been invited and has agreed to accept the position of consulting engineer to the company, so that his unrivalled experience of the oxygen gas industry will continue to be available. The appointment of a new chairman to succeed Mr. Murray will, it is stated, be announced later. Speaking at the last annual general meeting of the company, which was held in May last, Mr. Murray referred to the bicentenary of the birth of Priestley, the discoverer of oxygen, and the early history of his own company and its experiences with the Brin barium process nearly a century later. Mr. Murray may be looked upon as the man who made oxygen a commercial product, and his many friends will wish him a long and useful life in his new capacity as honorary governor of his company.

The Uses of Tin.

According to a survey of the industrial applications of the metal tin, which has been carried out under the supervision of Mr. D. J. Macnaughtan, research director of the International Tin Research and Development Council, of Mansfield House, 378, Strand, London, W.C.2, there are nearly 200 uses of tin in manufactures. The chief industrial consumers of tin, the survey shows, are the tin-plate, automobile, heavy engineering, shipbuilding, electrical, chemical and food industries, but the range of tin-consuming industries extends further and embraces armaments, pewter, plumbing, and the manufacture of bells. The forms in which tin is employed are analysed in the survey under sections devoted to tin alloys, pure tin, tin foil, pewter, tin-plate, terne plate, tinned iron, tinned steel and copper, electro-deposited tin, and tin compounds. In the tin-alloy section mention is particularly made of bronzes for bearings, turbine blading and propellers, and the lead-tin alloys employed in type metals, pipes, solders and cable sheathing. Tin-plate is widely used for sheet metal work and the canning industries, while terne plate finds a use as roofing and in the construction of motor bodies and storage tanks. Tinned iron, steel and copper, have wide and varied uses. Electro-deposited tin is applied to the cast iron pistons of motor cars, and for the tinning of coils and component parts, while tinfoil finds extensive uses for electrical condensers, and is used in the making of ammunition for large guns, as it diminishes the fouling of the bore with copper from the driving band.

Waterloo Bridge.

In anticipation of the tenders which will in due course be invited for the reconditioning of Waterloo Bridge, the London County Council issued on Monday last an official statement with regard to the extent of the work contemplated. Piers Nos. 2, 3, 4, and 7, numbering from north abutment, are to be underpinned, while arches Nos. 5, 6, and 7, and piers Nos. 5 and 6 are to be taken down and rebuilt. The foundations of every pier except No. 1, which is incorporated in the Victoria Embankment wall, and No. 8 on the Lambeth foreshore, are to be given an effective bearing area of not less than 3000 square feet at a level of not less than 35ft. below Ordnance datum, and the carriageway is to be widened by corbelling. The scheme of reconditioning will follow the general lines of the report prepared by Messrs. Rendel, Palmer and Tritton, of Westminster, but tenderers are to be allowed certain freedom of action. They may accept the given scheme or they may submit alternative schemes for execution. Altogether the estimated cost of underpinning and corbelling-out is put at £685,000, and the treatment, so far as corbelling-out is concerned, will be subject to the approval of the Royal Fine Arts Commission. During the process of underpinning, the bridge will be entirely closed and traffic diverted to the temporary steel bridge which was erected some years ago.

Timber Research.

During the year 25,000 mechanical tests and 30,700 physical tests and other determinations on timber specimens were made at the Forest Products Research Laboratory. "Increasing appreciation," says a report which has just been issued, "of the value of laboratory tests for the elucidation of specific problems is reflected in the considerable increase in the number of requests by outside bodies for mechanical strength tests. Many of these requests have been for tests to determine the extent to which blemishes, defects, methods of treatment, &c., affect the mechanical strength properties of the material relative to particular uses." The increase in the output from the testing laboratory is stated to have been due largely to increased work for the Empire. The information derived from the tests is of particular value in connection with the Empire timbers now being introduced, since the comparison between the properties of new timbers and timbers already in use, made possible by such data, enable potential uses and markets for the new timbers to be readily ascertained. The report notes with satisfaction the increasing commercial interest displayed in Empire timbers, which is attributed partly to a genuine desire on the part of consumers to utilise Empire products more extensively, and partly to the policy of Colonial Governments in developing their forest resources more intensively. At the instance of the Empire Marketing Board the Department released an experienced officer of the Laboratory so that he could be sent by the Board to Nigeria and the Gold Coast. The visit was made possible by the co-operation of the Colonial Governments concerned, and it is confidently hoped that as a result of it more intimate contact will be established between these regions of production and consumers in the United Kingdom.

Mablethorpe Waterworks.

On Thursday, September 28th, Colonel the Right Hon. the Lord Heneage officially opened the new waterworks and sewerage works at Mablethorpe, Lincolnshire, which have been constructed to the order of the Urban District Council of Mablethorpe and Sutton, under the direction of Mr. A. E. Baker, Engineer and Surveyor to the Council, and the consulting engineers, Messrs. Silcock and Simpson, of Westminster and Leeds. The water scheme comprises a 527ft. deep bore-hole sunk into the Spilsby sandstone at the village of Maltby-le-Marsh, which has a yield of approximately 27,000 gallons of water per hour. The pumping plant consists of two treble-barrel bucket and plunger type pumps, by Tangye, each of which is designed to deliver 15,000 gallons per hour against a total head of 190ft. The pumps are designed for a normal ten hours' pumping duty and run at 24½ r.p.m. They are driven by single-cylinder heavy oil engines through double reduction gearing. A ferro-concrete water tower, 36ft. diameter and 15ft. deep, carrying 100,000 gallons of water, the top of which is 95ft. above the ground level, has been built and serves with the rising main over 11 miles of distribution pipes. The cost of the whole undertaking amounts to about £36,000. The sewerage and sewage disposal works were constructed under the direction of the same consulting engineers and comprise an extensive system of new sewers with a collecting tank and a pumping plant consisting of three Harland vertical spindle electrically driven sewage pumps. The unscreened sewage is delivered to the disposal works through a 15in. rising main. The disposal plant consists of an equalising tank with sedimentation tanks, bacteria beds, and storm water tanks, complete with Lister oil engine-driven sludge pumps and sludge drying beds. The estimated cost of the whole plant is about £42,500.

A Proposed Forth Road Bridge.

At a conference of representative local authorities, which took place at Stirling on Monday, October 2nd, a letter was read from the Ministry of Transport, stating that the Minister would be prepared to offer a grant towards the construction of a new road bridge over the river Forth, from Kincardine-on-Forth to Higgin's Neuk, at a rate of 75 per cent. of the total cost of the bridge. The proposed new bridge will, it is estimated, cost £327,000 and will be about half-a-mile in length. It will have twelve spans of 50ft. and two central spans of 150ft., which will be of the pivotal type, in order to allow ships to pass. The roadway will be carried at about 30ft. above the water level. Two years ago the Government was prepared to offer 85 per cent. of the cost, which was then estimated at £238,609, for the bridge foundations and structural steel work, and the local authorities accepted a tender from the Cleveland Bridge and Engineering Company, Ltd., of Darlington, for the work. Owing, however, to the change in financial policy the grant was withdrawn. The local authorities are now consulting with neighbouring authorities with a view to their assisting in carrying forward the scheme.

The French Liner Normandie.

In view of the revival of interest displayed in the possible early resumption of work on the large Cunard liner, now on the stocks at John Brown's Clydebank yard, and the report in favour of continuance of work on her, which, it is understood, has been made to the Government by Lord Weir, the remarks made by Monsieur Henri Cangardel, the Administrative Director-General of the Compagnie Générale Transatlantique, at the company's recent annual meeting in Paris, on the completion and operation of the "Normandie," are of special interest. Monsieur Cangardel announced that the new liner, which, it was estimated, would cost over £5,600,000 (at par), would be put into service in either April or May, 1935. The hull structure, he said, was completely finished and the turbo-electric propelling machinery was being installed. The fitting out of the ship, by reason of her large size, required much thought, but it was proceeding satisfactorily. He denied that the new liner was in any sense a monster, for she did not, he said, exceed by much the length of the last large liners designed before 1914. In view, however, of her larger engine power and the greater width of hull, her tonnage was higher than that of previous vessels. She would, he was of opinion, cross the Atlantic at a speed not conceived of formerly, and both the owners and their engineers had every hope that she would exceed her designed contract speed.

The Shipping, Engineering and Machinery Exhibition at Olympia.

No. V.

(Concluded from page 304, September 29th.)

Dobbie, McInnes and Clyde, Ltd.

In our issue of May 3rd, 1929, we described and illustrated the instrument known as the "Stabilograph," as made in accordance with the patent of Professor T. B. Abell, by Dobbie, McInnes and Clyde, Ltd., of Glasgow. An example of this instrument was included among the large variety of exhibits shown on the company's stand. It consists of a heavy compound pendulum of short period, suspended on knife edges, the movement of which is transmitted in magnified ratio through gearing to a pen arm, the pen of which traces a line on a chart fixed round a clock-driven drum. The chart is about 6in. in height, and, with the normal ratio of the gearing between the pendulum and the pen arm, the movement of the pen from the top to the foot of the chart represents an angular movement of the pendulum from +3 deg. to −3 deg. A plunger attached to the pendulum operates inside a dashpot to damp out transient vibrations.

The instrument is employed to measure the metacentric heights of ships. For this purpose the heel which it records when a known weight is applied at one side of the ship is noted, the G M thereafter being either calculated from the familiar formula or read off from a chart supplied with the instrument. The "Stabilograph" can also be used as an accelerometer to indicate changes in the speed of a ship or alternatively to show when the speed is constant. For this duty it is set up with the knife edge axis of the pendulum running athwartship. Changes in the speed of the ship will then cause the pendulum to lag behind or swing in front of the vertical position, according as the change is an acceleration or a deceleration. As an accelerometer it may be employed to record the changes of speed occurring during the launch of a ship. If the declivity of the launching ways is known, the information which it provides permits the coefficients of the initial and sliding friction to be calculated.

To measure the natural period of rolling of a ship in still water, the "Stabilograph" can be set up with its pendulum knife edge axis running fore and aft. The ship is then heeled through a small angle—necessarily less than 3 deg.—and the period of the subsequent oscillation determined by averaging the time over five or ten swings, as recorded on the chart. It is claimed that any swing which the pendulum may acquire in its own natural period during this process is not sufficient noticeably to affect the estimation of the ship's period.

For measuring the period of rolling in a seaway, the pen arm can be changed for another, the gear ratio of which is such as to reduce the magnification ratio to a tenth of its normal value. With this arm the full movement of the pen from the top to the foot of the chart corresponds with a heel from +30 deg. to −30 deg. When the instrument is required for this purpose it is fitted with a stronger damping system, consisting of a modified design of dashpot and plunger. To measure the metacentric height this same dashpot may be employed in conjunction with the standard 3 deg. pen arm.

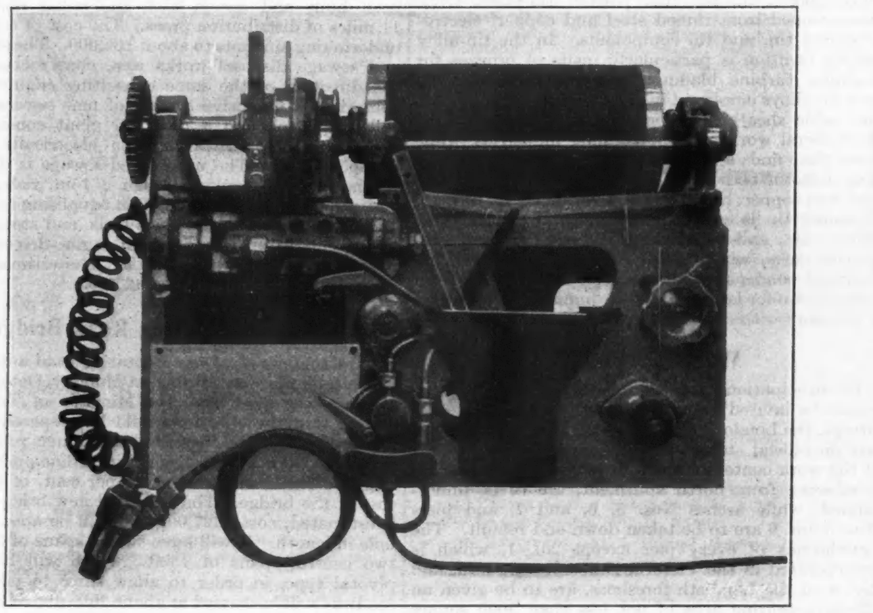


Fig. 107—"Farnboro" Electric Indicator—Dobbie, McInnes

The chart drum normally fitted makes one revolution in 20 minutes. For some purposes, as, for example, for taking high-speed acceleration diagrams, it may be replaced by a high-speed drum making one revolution in 5 minutes.

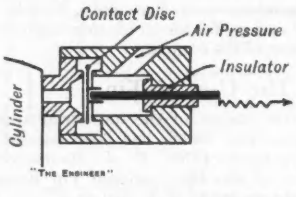


Fig. 108—Disc Valve Unit

The principle of the Farnboro (R.A.E.) electric indicator, Fig. 107, another of the firm's exhibits, was first explained in a paper by Mr. Harry Wood, presented at a meeting of the Institution of Mechanical Engineers in January, 1923. To the cylinder to be indicated, there is attached a disc valve unit, shown diagrammatically in Fig. 108, comprising a contact disc mounted on a stem which is insulated from the body of the unit. The disc is free to move through a small gap between two valve seats. Air pressure is admitted to one side of the disc and the cylinder pressure to the other. If the air pressure is maintained constant at any arbitrary value, the disc will remain in contact with the left-hand valve seat until the pressure inside the engine cylinder rises to equality with the air pressure. The disc will then move into contact with the right-hand seat, and will remain in contact with it until, later in the engine cycle, the cylinder pressure falls to equality with the air pressure when the disc will once again change its seat. The movement of the disc in either direction breaks the primary current of an electric circuit containing an induction coil. The high-tension voltage induced in the secondary circuit at the instant when the primary circuit is broken causes a spark to jump a gap in the secondary circuit. In this gap a sheet of opaque paper is situated. This paper is perforated by the spark.

The paper is mounted on a drum driven by gearing or chain from the engine crank shaft at the engine speed—or at half the engine speed in the case of a four-stroke cycle engine. The sparking point is situated at the end of a lever forming part of a link-work system, and has a motion parallel with the axis of the drum and just clear of the surface of the paper. The link-work system is moved by means of a piston coupled to one of its elements. This piston is pulled within its cylinder towards the left—in Fig. 107—by a pair of tension springs, and is moved towards the right by air pressure acting on one face of the piston. This air pressure is the same as that acting on the disc of the valve unit, Fig. 108. In this way the position of the sparking point horizontally is a measure of the air pressure, and therefore of the engine cylinder pressure at the instant at which sparking occurs. The precise value of the pressure represented can be deduced from a knowledge of the spring calibration. At the same time the vertical movement of the paper past the sparking point is a measure of the angle through which the engine crank shaft has turned. The co-ordinates of the perforated point therefore define the occurrence within the engine cylinder of a certain pressure when the crank has reached a certain angle.

In general, if the air pressure is maintained constant and the running of the engine is not altered, two sparks will occur per cycle, the first indicating the attainment by the engine pressure of a value equal to the air pressure on the rise during compression, and the second the re-attainment of equality on the fall during expansion. These two sparks will pass through the paper at the same pair of points on successive cycles. A progressive alteration in the air pressure, starting from atmospheric and increasing it, will therefore give a succession of pairs of points until the maximum engine pressure is reached, when the two points will coalesce. If the air pressure is increased beyond this point, sparking will cease. The diagram obtained is in the form shown in Fig. 109. It is a pressure-crank angle diagram, but from a knowledge of the engine dimensions it can readily be converted into the familiar pressure-volume form. The fact that any one diagram is built up over a period covering a number of successive engine cycles is advantageous, in that it eliminates the possibility, present in the case of single-cycle diagrams, of an isolated non-representative cycle being indicated.

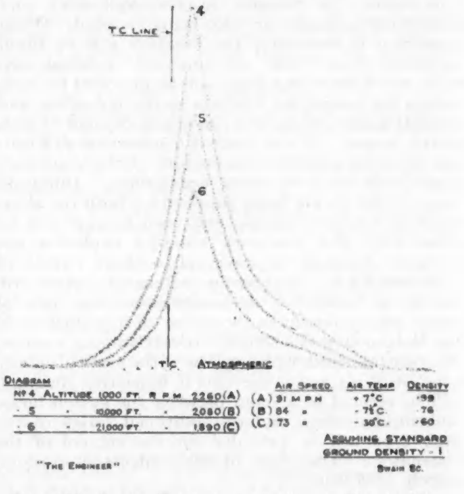


Fig. 109—Aero Engine Indicator Diagrams

The air pressure is supplied from an air bottle charged to 120 atmospheres. A bottle of about 600 cubic inches actual capacity—equivalent to 40 cubic feet free air capacity—is normally sufficient to permit fifty complete diagrams to be taken. Four different pairs of calibrated tension springs are supplied with each instrument. Their "scales" are 40 lb., 80 lb., 100 lb., and 150 lb. per square inch per inch of horizontal movement of the sparking point. They therefore permit diagrams 7½in. high to be obtained with maximum pressures of 300 lb., 600 lb., 750 lb., and 1125 lb. per square inch respectively.

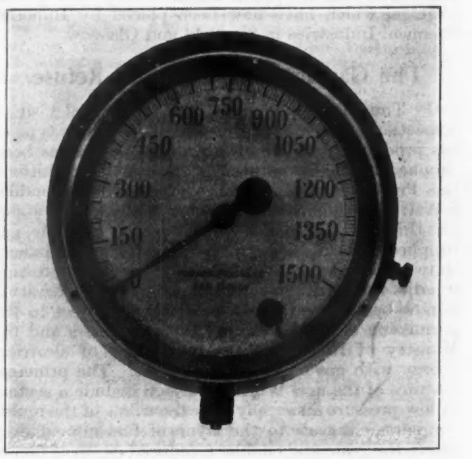


Fig. 110—Electric Maximum Pressure Gauge

The combination of tension springs and air under pressure allows the instrument to record only pressures above atmospheric. To deal with any subatmospheric portion of the cycle compression springs and a vacuum have to be employed. A pair of compression springs forms a permanent part of the piston and cylinder mechanism operating the sparking point link-work system. These two springs become effective simply when the tension springs are removed. The vacuum required is created by a small hand pump forming part of the equipment. The vacuum is applied to the disc of the valve unit and to the piston of the spring cylinder in the same way as the air pressure. The vacuum pump can be changed by means of a cock into a pressure pump, for use when light spring diagrams are required.

For indicating a multi-cylinder engine the only element which need be duplicated is the disc valve unit. With one such unit for each cylinder and a multiple-way electric switch the cylinders can be quickly indicated in succession.

A recent development consists of the introduction of a differential plunger valve unit, which permits very high pressures to be recorded, such as the fuel injection pressure in an oil engine and the manner in which it rises and falls during the injection period. This differential valve unit may be inserted anywhere in the fuel delivery pipe, and enables the injection pressure to be recorded on the same diagram as the working cylinder pressure and in correct relationship thereto with respect to the instant of occurrence. In this differential unit the disc is operated not by the pressures acting directly on its two faces, but by means of a plunger which has ten times as great an area on the air pressure side as it has on the engine pressure side. With the standard tension springs, this differential valve unit enables maximum pressures of from 3000 lb. to 11,250 lb. per square inch to be recorded. It is to be noted that the oscillating part of this unit, consisting of the disc and the differential plunger, is of relatively considerable mass, as compared with the simple disc of the normal valve unit. The differential pattern is therefore not suitable for use in conjunction with very high speeds.

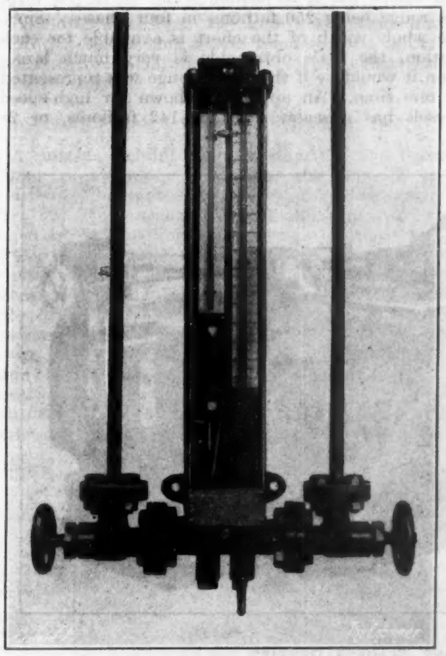


Fig. 111—"Teledep" Boiler Water Level Gauge—Dobbie, McInnes

The differential unit is also made with a 5-to-1 ratio for use in indicating compressors and supercharged engines.

Another recent development consists of an arrangement of certain auxiliary electric circuits, whereby the top dead centre line may be sparked on the diagram while an actual record is being taken, thereby eliminating the previously employed method of inscribing this line with the engine stopped. Lines of constant pressure can, in addition, be recorded on the paper during the operation of the instrument. These lines obviate the necessity for subsequent calibration.

For some purposes it is useful to be able to measure the maximum pressure occurring in a cycle without indicating the whole cycle through which the pressure passes. In these circumstances the "Farnboro" electric pressure gauge—Fig. 110—may be employed in conjunction with an air bottle and a disc valve unit, battery, and induction coil, as used in connection with the "Farnboro" indicator. The air pressure applied to one side of the disc is also applied to the gauge to move the pointer. The air gap in the secondary circuit occurs at the tip of the pointer. Hence, as the air pressure is raised sparking occurs at the tip of the pointer until the maximum pressure occurring in the cycle is reached when sparking ceases. By means of a multiway switch and distribution box, this gauge permits the maximum pressures occurring in the cylinders of a multi-cylinder engine to be determined quickly in succession.

Another interesting instrument exhibited by Dobbie, McInnes and Clyde, Ltd., was the "Teledep" remote-reading boiler water level gauge—Figs. 111 and 112. Two chambers or flanged connections C D are coupled through shut-off cocks to the boiler shell, an internal lip inside the chamber C being set 6½in. above the mean water level, and the other connection D being set at least 13in. below the datum level defined by this lip. Copper pipes A B of any length lead to the "Teledep" gauge, which may be situated at any convenient point or level below the boiler. The tubes A B terminate at valves G H leading to a central body casting, from which an inverted U tube rises upwards. This U tube consists of two glasses J K cross connected at their upper ends, and a metal body P and tube forming the lower part of the limb J. The two limbs at their lower ends are open to the valves G H respectively. Drains R and S are provided for use in connection with the charging of the gauge. In service, water fills both the tubes, the tube A being initially charged up to the datum lip and subsequently being kept full by condensation. The water enters both limbs of the U tube. It stands at different levels in the two glasses and traps a certain volume of compressed air in the upper part of the U tube. Behind the limb K there is a sliding scale graduated upwards and downwards from a zero mark at the middle of its length. A pointer on this scale opposite the 6½in. graduation above the zero is adjusted to tally with the water level in the glass J. The reading of the water level in the glass K, taken with reference to the zero of the scale, then shows the height in inches at which the water in the boiler is standing above or below the mean water level. For any changes of pressure occurring in normal working, the alteration in the level of the water in the glass J is insignificant. After a preliminary setting, therefore, the scale does not require to be adjusted each time a reading is taken.

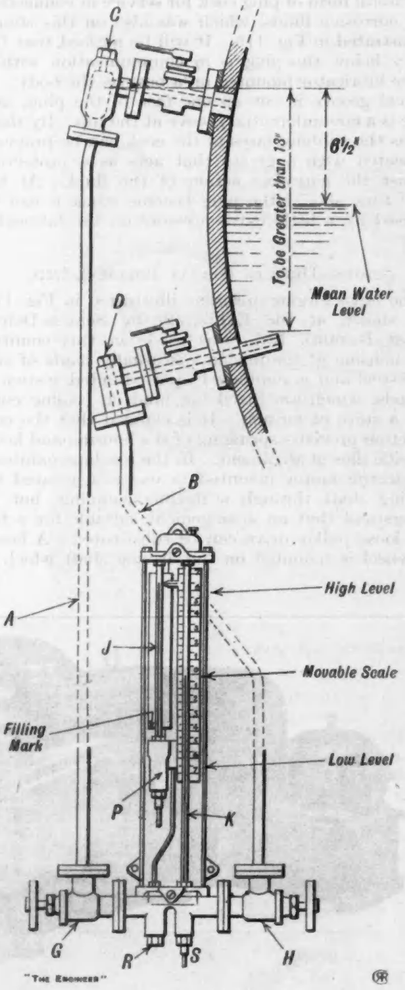


Fig. 112—"Teledep" Gauge and Fittings

A modified arrangement is provided to permit the gauge to be mounted above the level of the boiler.

Bradley and Foster, Ltd.

For those to whom cast iron is just cast iron and nothing more, a visit to the stand taken by Bradley and Foster, Ltd., of Darlaston, must have been of great interest. The exhibits consisted of a very wide range of refined pig irons with a bewildering variety of compositions, suitable for producing cast irons with various properties. One of the most interesting exhibits was a complete range of fractures of malleable pig iron designed to show the regular practice of the firm in grading into ten fractures. There can be little doubt that were some such standard system adopted universally producers of pig irons would benefit considerably. Another range of irons—blended all-mine pig—is produced by the firm in a range of compositions to suit individual requirements. The range is the outcome of extensive investigations carried out with the object of matching the properties of cold blast, Swedish, and charcoal irons, and the makers now claim that they have devised means of blending together suitable materials to match exactly the specific properties of the various cold blast and charcoal irons examined. Of particular interest to foundrymen who receive inquiries for castings of special composition, or to specified mechanical tests, were the alloy irons exhibited, many of them for the first time. The qualities ranged from low nickel-chrome irons for direct use up to various types of austenitic ingots. The variety of pig irons was so wide that it is quite impossible here to mention everything.

Loranco Ltd.

The stand of Loranco Ltd., 38, Sydenham-road, London, S.E.26, was principally devoted to small tools of foreign origin, and among them there were several of notable interest. There was, for instance, a light sensitive drilling machine driven by its own electric motor, through a belt and an automatic clutch. This clutch is brought into operation by the engagement of a spline on the drill shaft when the feed lever is pulled down, so that the motor and belt may be running continuously, but the drill spindle only starts to move when the feed is put on; the clutch slips if the feed is so gross as to endanger the drill. There were also on this stand some very high-speed rotary tools—see Fig. 113—for speeds up to 100,000 revolutions per minute. These tools are driven by little air turbines working at pressures of from 30 lb. to 100 lb. per square inch, and are notable on account of their lack of vibration. The air consumption is from 7 to 10 cubic feet per minute. With the help of a small pencil-shaped abrasive

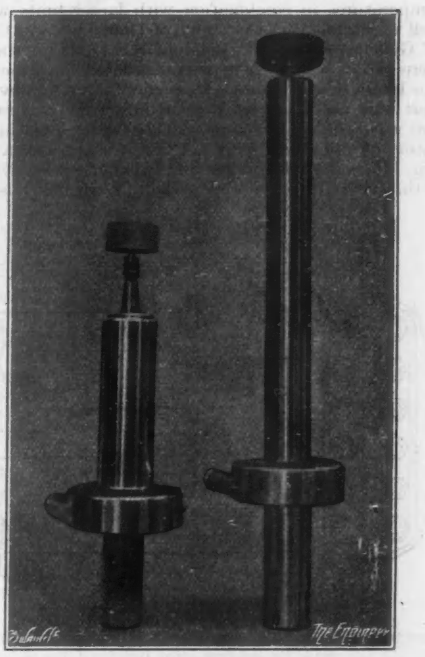


Fig. 113—High-Speed Rotary Tools—Loranco

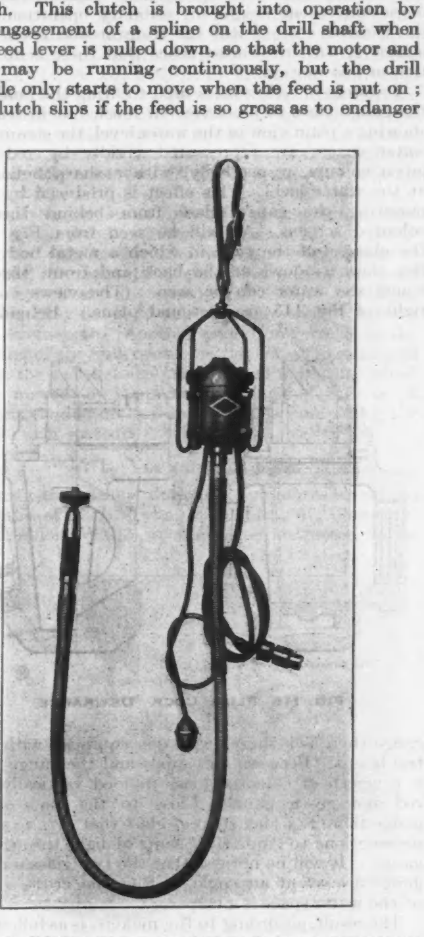


Fig. 114—¼ H.P. Flexible Shaft Outfit—Loranco

The Shipping, Engineering and Machinery Exhibition at Olympia.

No. V.

(Concluded from page 304, September 29th.)

Dobbie, McInnes and Clyde, Ltd.

In our issue of May 3rd, 1929, we described and illustrated the instrument known as the "Stabilograph," as made in accordance with the patent of Professor T. B. Abell, by Dobbie, McInnes and Clyde, Ltd., of Glasgow. An example of this instrument was included among the large variety of exhibits shown on the company's stand. It consists of a heavy compound pendulum of short period, suspended on knife edges, the movement of which is transmitted in magnified ratio through gearing to a pen arm, the pen of which traces a line on a chart fixed round a clock-driven drum. The chart is about 6in. in height, and, with the normal ratio of the gearing between the pendulum and the pen arm, the movement of the pen from the top to the foot of the chart represents an angular movement of the pendulum from +3 deg. to −3 deg. A plunger attached to the pendulum operates inside a dashpot to damp out transient vibrations.

The instrument is employed to measure the metacentric heights of ships. For this purpose the heel which it records when a known weight is applied at one side of the ship is noted, the G M thereafter being either calculated from the familiar formula or read off from a chart supplied with the instrument. The "Stabilograph" can also be used as an accelerometer to indicate changes in the speed of a ship or alternatively to show when the speed is constant. For this duty it is set up with the knife edge axis of the pendulum running athwartship. Changes in the speed of the ship will then cause the pendulum to lag behind or swing in front of the vertical position, according as the change is an acceleration or a deceleration. As an accelerometer it may be employed to record the changes of speed occurring during the launch of a ship. If the declivity of the launching ways is known, the information which it provides permits the coefficients of the initial and sliding friction to be calculated.

To measure the natural period of rolling of a ship in still water, the "Stabilograph" can be set up with its pendulum knife edge axis running fore and aft. The ship is then heeled through a small angle—necessarily less than 3 deg.—and the period of the subsequent oscillation determined by averaging the time over five or ten swings, as recorded on the chart. It is claimed that any swing which the pendulum may acquire in its own natural period during this process is not sufficient noticeably to affect the estimation of the ship's period.

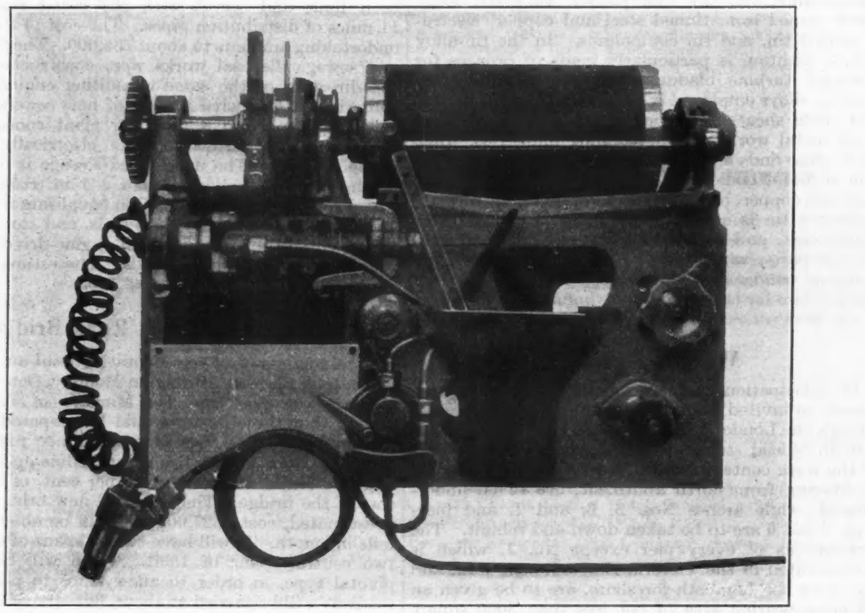


Fig. 107—"Farnboro" Electric Indicator—Dobbie, McInnes

For measuring the period of rolling in a seaway, the pen arm can be changed for another, the gear ratio of which is such as to reduce the magnification ratio to a tenth of its normal value. With this arm the full movement of the pen from the top to the foot of the chart corresponds with a heel from +30 deg. to −30 deg. When the instrument is required for this purpose it is fitted with a stronger damping system, consisting of a modified design of dashpot and plunger. To measure the metacentric height this same dashpot may be employed in conjunction with the standard 3 deg. pen arm.

The chart drum normally fitted makes one revolution in 20 minutes. For some purposes, as, for example, for taking high-speed acceleration diagrams, it may be replaced by a high-speed drum making one revolution in 5 minutes.

The principle of the Farnboro (R.A.E.) electric indicator, Fig. 107, another of the firm's exhibits, was first explained in a paper by Mr. Harry Wood, presented at a meeting of the Institution of Mechanical Engineers in January, 1923. To the cylinder to be indicated, there is attached a disc valve unit, shown diagrammatically in Fig. 108, comprising a contact disc mounted on a stem which is insulated from the body of the unit. The disc is free to move through a small gap between two valve seats. Air pressure is admitted to one side of the disc and the cylinder pressure to the other. If the air pressure is maintained constant at any arbitrary value, the disc will remain in contact with the left-hand valve seat until the pressure inside the engine cylinder rises to equality with the air pressure. The disc will then move into contact with the right-hand seat, and will remain in contact with it until, later in the engine cycle, the cylinder pressure falls to equality with the air pressure when the disc will once again change its seat. The movement of the disc in either direction breaks the primary current of an electric circuit containing an induction coil. The high-tension voltage induced in the secondary circuit at the instant when the primary circuit is broken causes a spark to jump a gap in the secondary circuit. In this gap a sheet of opaque paper is situated. This paper is perforated by the spark.

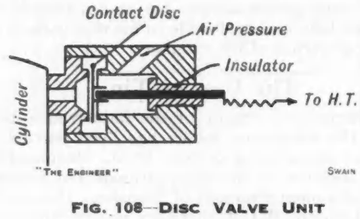


Fig. 108—Disc Valve Unit

The paper is mounted on a drum driven by gearing or chain from the engine crank shaft at the engine speed—or at half the engine speed in the case of a four-stroke cycle engine. The sparking point is situated at the end of a lever forming part of a link-work system, and has a motion parallel with the axis of the drum and just clear of the surface of the paper. The link-work system is moved by means of a piston coupled to one of its elements. This piston is pulled within its cylinder towards the left—in Fig. 107—by a pair of tension springs, and is moved towards the right by air pressure acting on one face of the piston. This air pressure is the same as that acting on the disc of the valve unit, Fig. 108. In this way the position of the sparking point horizontally is a measure of the air pressure, and therefore of the engine cylinder pressure at the instant at which sparking occurs. The precise value of the pressure represented can be deduced from a knowledge of the spring calibration. At the same time the vertical movement of the paper past the sparking point is a measure of the angle through which the engine crank shaft has turned. The co-ordinates of the perforated point therefore define the occurrence within the engine cylinder of a certain pressure when the crank has reached a certain angle.

In general, if the air pressure is maintained constant and the running of the engine is not altered, two sparks will occur per cycle, the first indicating the attainment by the engine pressure of a value equal to the air pressure on the rise during compression, and the second the re-attainment of equality on the fall during expansion. These two sparks will pass through the paper at the same pair of points on successive cycles. A progressive alteration in the air pressure, starting from atmospheric and increasing it, will therefore give a succession of pairs of points until the maximum engine pressure is reached, when the two points will coalesce. If the air pressure is increased beyond this point, sparking will cease. The diagram obtained is in the form shown in Fig. 109. It is a pressure-crank angle diagram, but from a knowledge of the engine dimensions it can readily be converted into the familiar pressure-volume form. The fact that any one diagram is built up over a period covering a number of successive engine cycles is advantageous, in that it eliminates the possibility, present in the case of single-cycle diagrams, of an isolated non-representative cycle being indicated.

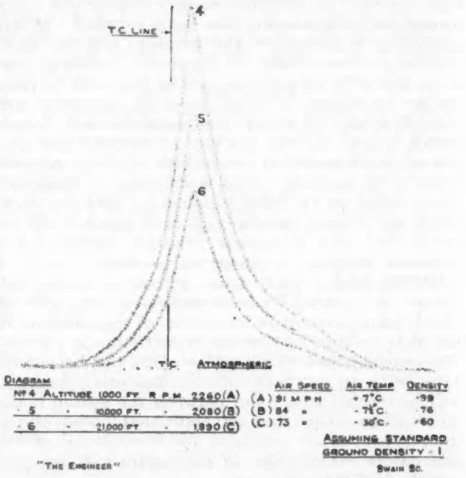


Fig. 109—Aero Engine Indicator Diagrams

The air pressure is supplied from an air bottle charged to 120 atmospheres. A bottle of about 600 cubic inches actual capacity—equivalent to 40 cubic feet free air capacity—is normally sufficient to permit fifty complete diagrams to be taken. Four different pairs of calibrated tension springs are supplied with each instrument. Their "scales" are 40 lb., 80 lb., 100 lb., and 150 lb. per square inch per inch of horizontal movement of the sparking point. They therefore permit diagrams 7½in. high to be obtained with maximum pressures of 300 lb., 600 lb., 750 lb., and 1125 lb. per square inch respectively.

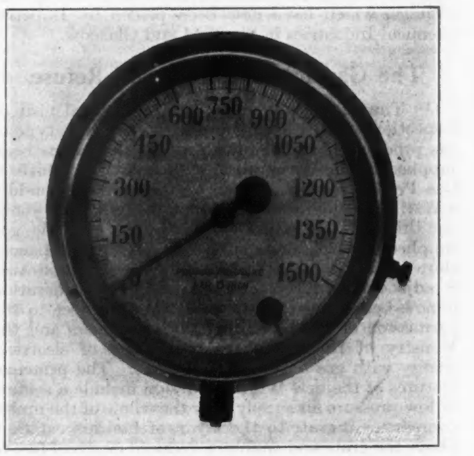


Fig. 110—Electric Maximum Pressure Gauge

The combination of tension springs and air under pressure allows the instrument to record only pressures above atmospheric. To deal with any sub-atmospheric portion of the cycle compression springs and a vacuum have to be employed. A pair of compression springs forms a permanent part of the piston and cylinder mechanism operating the sparking point link-work system. These two springs become effective simply when the tension springs are removed. The vacuum required is created by a small hand pump forming part of the equipment. The vacuum is applied to the disc of the valve unit and to the piston of the spring cylinder in the same way as the air pressure. The vacuum pump can be changed by means of a cock into a pressure pump, for use when light spring diagrams are required.

For indicating a multi-cylinder engine the only element which need be duplicated is the disc valve unit. With one such unit for each cylinder and a multiple-way electric switch the cylinders can be quickly indicated in succession.

A recent development consists of the introduction of a differential plunger valve unit, which permits very high pressures to be recorded, such as the fuel injection pressure in an oil engine and the manner in which it rises and falls during the injection period. This differential valve unit may be inserted anywhere in the fuel delivery pipe, and enables the injection pressure to be recorded on the same diagram as the working cylinder pressure and in correct relationship thereto with respect to the instant of occurrence. In this differential unit the disc is operated not by the pressures acting directly on its two faces, but by means of a plunger which has ten times as great an area on the air pressure side as it has on the engine pressure side. With the standard tension springs, this differential valve unit enables maximum pressures of from 3000 lb. to 11,250 lb. per square inch to be recorded. It is to be noted that the oscillating part of this unit, consisting of the disc and the differential plunger, is of relatively considerable mass, as compared with the simple disc of the normal valve unit. The differential pattern is therefore not suitable for use in conjunction with very high speeds.

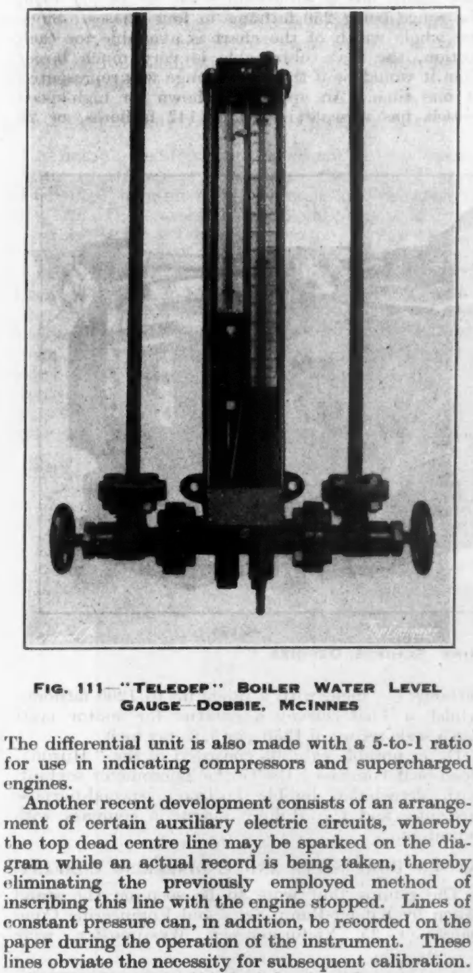


Fig. 111—"Teledep" Boiler Water Level Gauge—Dobbie, McInnes

The differential unit is also made with a 5-to-1 ratio for use in indicating compressors and supercharged engines.

Another recent development consists of an arrangement of certain auxiliary electric circuits, whereby the top dead centre line may be sparked on the diagram while an actual record is being taken, thereby eliminating the previously employed method of inscribing this line with the engine stopped. Lines of constant pressure can, in addition, be recorded on the paper during the operation of the instrument. These lines obviate the necessity for subsequent calibration.

For some purposes it is useful to be able to measure the maximum pressure occurring in a cycle without indicating the whole cycle through which the pressure passes. In these circumstances the "Farnboro" electric pressure gauge—Fig. 110—may be employed in conjunction with an air bottle and a disc valve unit, battery, and induction coil, as used in connection with the "Farnboro" indicator. The air pressure applied to one side of the disc is also applied to the gauge to move the pointer. The air gap in the secondary circuit occurs at the tip of the pointer. Hence, as the air pressure is raised sparking occurs at the tip of the pointer until the maximum pressure occurring in the cycle is reached when sparking ceases. By means of a multiway switch and distribution box, this gauge permits the maximum pressures occurring in the cylinders of a multi-cylinder engine to be determined quickly in succession.

Another interesting instrument exhibited by Dobbie, McInnes and Clyde, Ltd., was the "Teledep" remote-reading boiler water level gauge—Figs. 111 and 112. Two chambers or flanged connections C D are coupled through shut-off cocks to the boiler shell, an internal lip inside the chamber C being set 6½in. above the mean water level, and the other connection D being set at least 13in. below the datum level defined by this lip. Copper pipes A B of any length lead to the "Teledep" gauge, which may be situated at any convenient point or level below the boiler. The tubes A B terminate at valves G H leading to a central body casting, from which an inverted U tube rises upwards. This U tube consists of two glasses J K cross connected at their upper ends, and a metal body P and tube forming the lower part of the limb J. The two limbs at their lower ends are open to the valves G H respectively. Drains R and S are provided for use in connection with the charging of the gauge. In service, water fills both the tubes, the tube A being initially charged up to the datum lip and subsequently being kept full by condensation. The water enters both limbs of the U tube. It stands at different levels in the two glasses and traps a certain volume of compressed air in the upper part of the U tube. Behind the limb K there is a sliding scale graduated upwards and downwards from a zero mark at the middle of its length. A pointer on this scale opposite the 6½in. graduation above the zero is adjusted to tally with the water level in the glass J. The reading of the water level in the glass K, taken with reference to the zero of the scale, then shows the height in inches at which the water in the boiler is standing above or below the mean water level. For any changes of pressure occurring in normal working, the alteration in the level of the water in the glass J is insignificant. After a preliminary setting, therefore, the scale does not require to be adjusted each time a reading is taken.

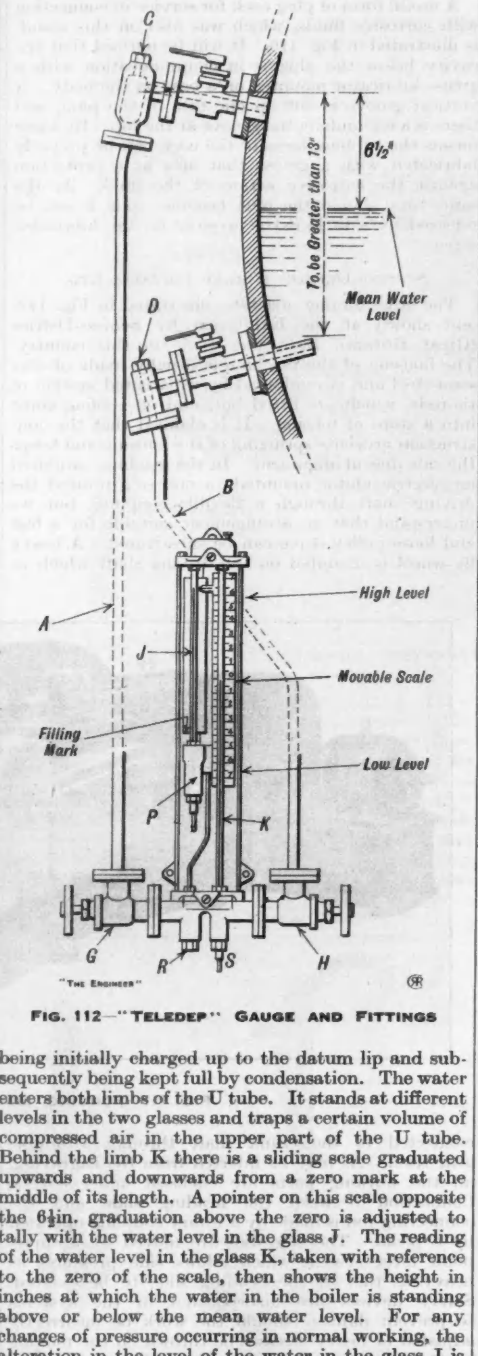


Fig. 112—"Teledep" Gauge and Fittings

A modified arrangement is provided to permit the gauge to be mounted above the level of the boiler.

Bradley and Foster, Ltd.

For those to whom cast iron is just cast iron and nothing more, a visit to the stand taken by Bradley and Foster, Ltd., of Darlaston, must have been of great interest. The exhibits consisted of a very wide range of refined pig irons with a bewildering variety of compositions, suitable for producing cast irons with various properties. One of the most interesting exhibits was a complete range of fractures of malleable pig iron designed to show the regular practice of the firm in grading into ten fractures. There can be little doubt that were some such standard system adopted universally producers of pig irons would benefit considerably. Another range of irons—blended all-mine pig—is produced by the firm in a range of compositions to suit individual requirements. The range is the outcome of extensive investigations carried out with the object of matching the properties of cold blast, Swedish, and charcoal irons, and the makers now claim that they have devised means of blending together suitable materials to match exactly the specific properties of the various cold blast and charcoal irons examined. Of particular interest to foundrymen who receive inquiries for castings of special composition, or to specified mechanical tests, were the alloy irons exhibited, many of them for the first time. The qualities ranged from low nickel-chrome irons for direct use up to various types of austenitic ingots. The variety of pig irons was so wide that it is quite impossible here to mention everything.

Loranco Ltd.

The stand of Loranco Ltd., 38, Sydenham-road, London, S.E.26, was principally devoted to small tools of foreign origin, and among them there were several of notable interest. There was, for instance, a light sensitive drilling machine driven by its own electric motor, through a belt and an automatic clutch. This clutch is brought into operation by the engagement of a spline on the drill shaft when the feed lever is pulled down, so that the motor and belt may be running continuously, but the drill spindle only starts to move when the feed is put on; the clutch slips if the feed is so gross as to endanger the drill. There were also on this stand some very high-speed rotary tools—see Fig. 113—for speeds up to 100,000 revolutions per minute. These tools are driven by little air turbines working at pressures of from 30 lb. to 100 lb. per square inch, and are notable on account of their lack of vibration. The air consumption is from 7 to 10 cubic feet per minute. With the help of a small pencil-shaped abrasive

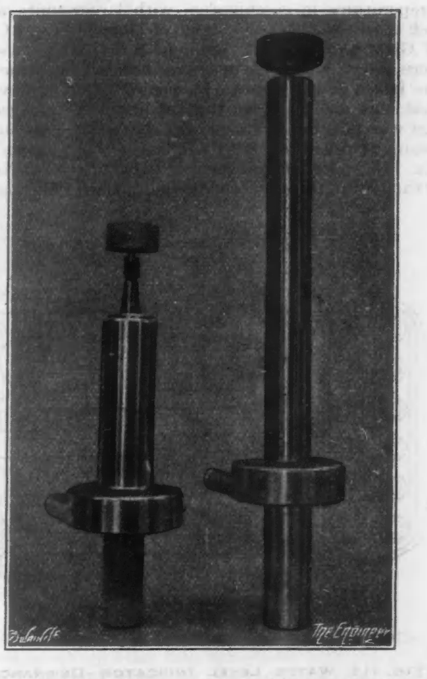


Fig. 113—High-Speed Rotary Tools—Loranco

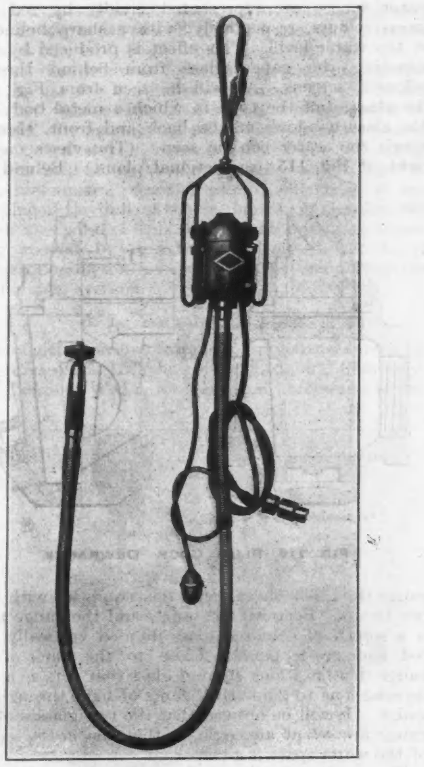


Fig. 114—¼ H.P. Flexible Shaft Outfit—Loranco

cutter we found it quite convenient to write script on a piece of plate glass.

There was also a little high-speed flexible shaft outfit, as shown in Fig. 114, for electric drives. It has a ¼ horse-power motor running at a speed of 10,000 revolutions per minute, and will operate a 2in. by ½in. grinding wheel. The flexible shaft has an inner core 10 mm. in diameter by 4ft. long, which floats in the motor shaft as it is bent. The outer casing is screwed directly on to the motor frame. The chuck runs on double ball bearings and takes tools with 6 mm. shanks.

Dewrance and Co.

The trend towards higher steam pressures and temperatures in combination with larger units was well exemplified on the stand of Dewrance and Co., of Great Dover-street, London, S.E.1, where there were shown a number of valves ordered for some of the latest power plants. It seemed to us, however, that this change from the conditions of a decade ago was best demonstrated by the water level indicator, of which the essential features are shown in Fig. 115, and which was referred to in our issue of Nov. 11th, 1932. In other words, the modern boiler is of such great dimensions and the water level gauge is so far above the floor that it is unreadable directly. The reading must consequently be transmitted to a more convenient height for ordinary operation. In the Dewrance apparatus the transmission is effected optically, with the consequence that there is no friction or lost motion.

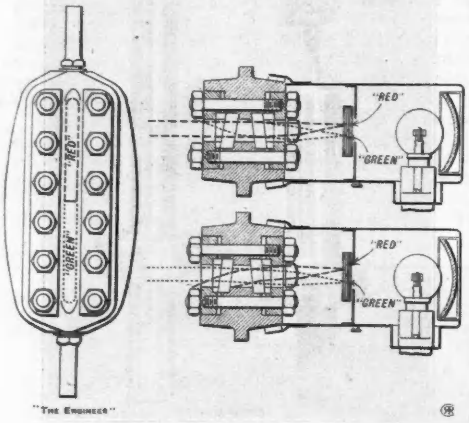


Fig. 115—Water Level Indicator—Dewrance

A system of reflectors is used to bring the image of the gauge glass to a convenient level, but instead of showing a plain view of the water level, the steam and water spaces are represented vividly by red and green colours, respectively, with a sharp boundary at the water level. This effect is produced by illuminating the gauge glass from behind through coloured screens. As will be seen from Fig. 115, the glass is of the type in which a metal body has flat glass windows at the back and front, through which the water can be seen. (The views on the right of Fig. 115 are sectional plans.) Behind the gauge there is a sheet metal box equipped with electric lamps. Between the lamps and the gauge there is a screen of coloured glass divided vertically into red and green panels. Close to the back of the gauge there is a long strip of glass that acts as a condensing lens to guide the beams of light through the gauge. It will be noticed that the two glasses of the gauge are set at an angle, so that the cross section of the water space is a trapezoid.

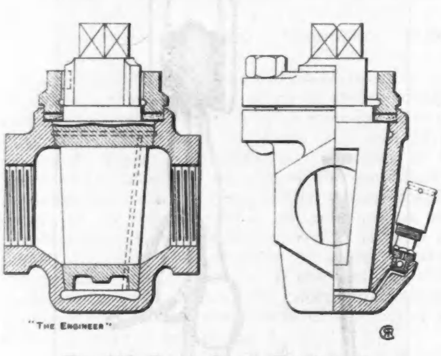


Fig. 116—Plug Cock—Dewrance

The result, according to the makers, is as follows :—Beams of red and green light are projected through the strip lens and strike the face of the glass plate at different angles, each being refracted. When the space between the glasses is occupied by steam the refractive index is such that the green beam of light is bent, so that it strikes the inside of the body of the gauge and does not emerge, whereas the red beam is so bent that it passes right through the gauge into the line of sight of the observer, who then sees a "red glass." These conditions are shown in the upper section. When the space between the glasses is occupied by water, however, the refractive index is such that the red beam of light is so bent that it strikes the inside of the body of the gauge and is lost, whereas the green beam is bent into the line of sight of the observer, who sees a "green glass." These conditions are shown in the lower section. Thus, it will be appreciated, the device illuminates the sight glass of the gauge in two colours—green for the water and red for the steam, and as the water level changes so the colours change, and the level can be clearly seen by the boiler attendant in the mirror below.

A useful form of plug cock for service in connection with corrosive fluids, which was also on this stand, is illustrated in Fig. 116. It will be noticed that the cavity below the plug is in communication with a grease lubricator mounted on a boss on the body. A vertical groove is cut up one face of the plug, and there is a circumferential groove at the top. By these means the rubbing faces of the cock can be properly lubricated with a grease that acts as a protection against the corrosive action of the fluid. At the same time should the plug become stuck it can be released by a little extra pressure on the lubricator screw.

Schiess-Defries (Great Britain), Ltd.

The large forging machine illustrated in Fig. 117, and shown at the Exhibition by Schiess-Defries (Great Britain), Ltd., was made in this country. The housing of the machine is usually made of cast semi-steel and is reinforced by a patented system of tie-rods, which are fitted hot, and on cooling come into a state of tension. It is claimed that the construction prevents springing of the housing and keeps the side dies in alignment. In the machine exhibited an electric motor mounted to one side rotated the driving shaft through a flexible coupling, but we understand that an arrangement suitable for a fast and loose pulley drive can be substituted. A heavy fly-wheel is mounted on the driving shaft which is, connected to the crank shaft through a double gear train. As may be inferred from the engraving, all the working parts are enclosed under covers. Connection between the heading slide and the connecting-rod is made by a rotary coupling operated by a pedal. The side dies are moved by a three-point lever system which allows side pressures as heavy as that of the heading slide to be exerted. Safety devices are incorporated in the systems to prevent damage should the work be incorrectly adjusted or heavy stresses be thrown on the moving parts by other means. An adjustable stop enabling the operator to insert the correct length of material is fitted. Some dimensions and other figures are given in the following table :—

End pressure ..	180 tons	Width of dies ..	130 mm.
Die opening ..	85 mm.	Stroke of dies ..	200 mm.
Height of dies ..	330 mm.	Strokes per minute	60
Length of dies ..	330 mm.	Power required ..	15 H.P.

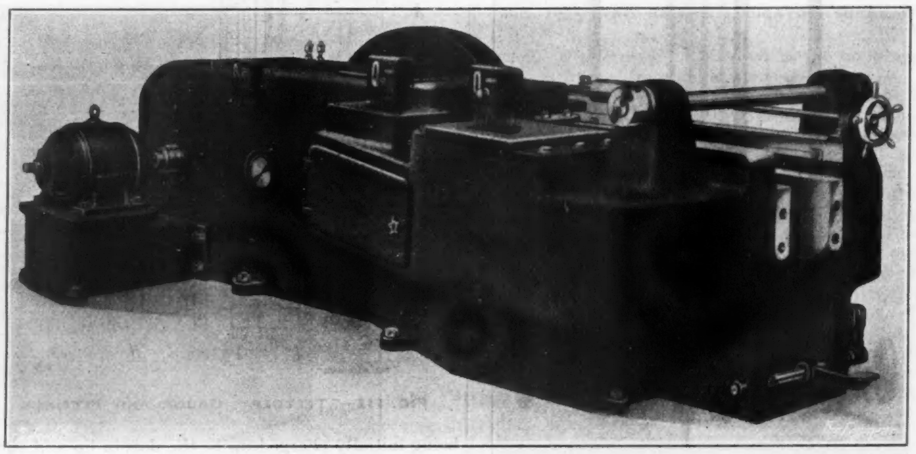


Fig. 117—Forging Machine—Schiess-Defries

Henry Hughes and Son, Ltd.

Navigational instruments of various kinds were shown by Henry Hughes and Son, Ltd., of 59, Fenchurch-street, E.C.3. One of the most interesting exhibits was the British Admiralty Magneto-striction apparatus, which may be provided with a recorder or dial, and which enables soundings to be recorded continuously and silently in any weather. The sound is produced by the vibration of a nickel magneto-strictive unit mounted in a small chamber within the ship. After passing through the ship's plating, the sound is reflected from the sea bed, and is received by a second magneto-strictive unit, which enables the time interval to be recorded on the wheel-house instrument from which the depth is read. Examples of typical installations were shown ranging from a portable outfit for river and harbour survey work, as illustrated with the case removed in Fig. 118, to the oceanic pattern in which the depth range is split up into sections by a system of phasing which allows an open scale to be used throughout the range. The oceanic recorder shown was, in general, similar to the Challenger instrument, and suitable for a range of 6000 fathoms. The scale of the record of the shallow water apparatus is 35 fathoms, or 7 fathoms per inch, with lines on the chart at every 5 fathoms, the accuracy being within 1ft.

Another equipment for merchant vessels, trawlers, and sloops has a 90-fathom scale, or 18 per inch, the range being 250 fathoms in four phases. Since the whole width of the chart is available for each section, the scale obtainable is very much larger than it would be if the whole range was represented at one time. An apparatus shown for high-speed vessels has a scale record of 142 fathoms, or 28 fathoms per inch, with a range up to 1200 fathoms, whilst a boat survey apparatus for motor craft has a scale record of 125ft., or 32ft. per inch.

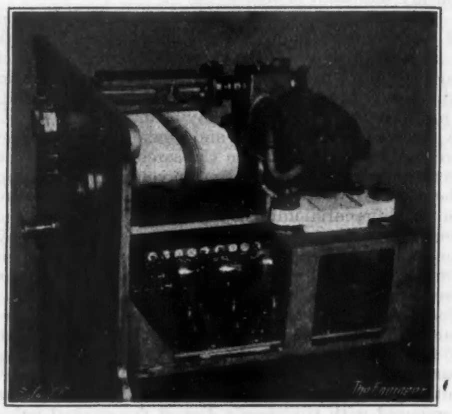


Fig. 118—Echo Sounding Recorder—Hughes

Other notable exhibits consisted of the "Husun" dead-beat compass; the Gothic micrometer sextant, with detachable bubble horizon; special-purpose sextants, and the Holmes magnetic compass with repeaters.

Kitson Pump Sales and Engineering Company.

The pumps that were to be seen on the stand taken by Kitson Pump Sales and Engineering Company, of 25, Victoria-street, Westminster, were all of the rotary type with moving blades. In Fig. 119 a photograph of a small pump of the firm's manufacture, with the barrel partly withdrawn to indicate its construction, is reproduced. There are only three moving parts, the rotor and two solid blades. The curve of the bore of the casing, the makers informed us, is so worked out that the blades

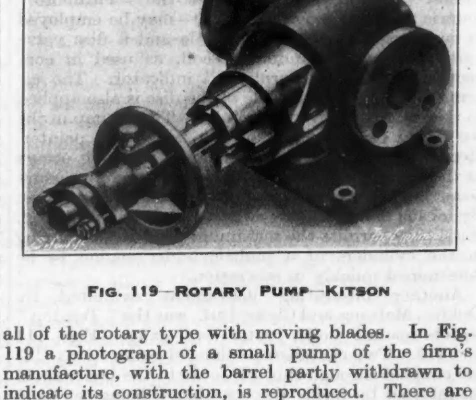


Fig. 119—Rotary Pump—Kitson

are guided into and out of the rotor slot at constant acceleration. As the blades are solid they are not pressed by springs or by any other means against the casing, which thus has a purely guiding action upon them. Hand pumps are made for capacities of 250 and 650 gallons per hour approximately against 60ft. head, and power-driven pumps in a range covering deliveries from 750 to 30,000 gallons per hour against heads of 75ft. to 150ft.

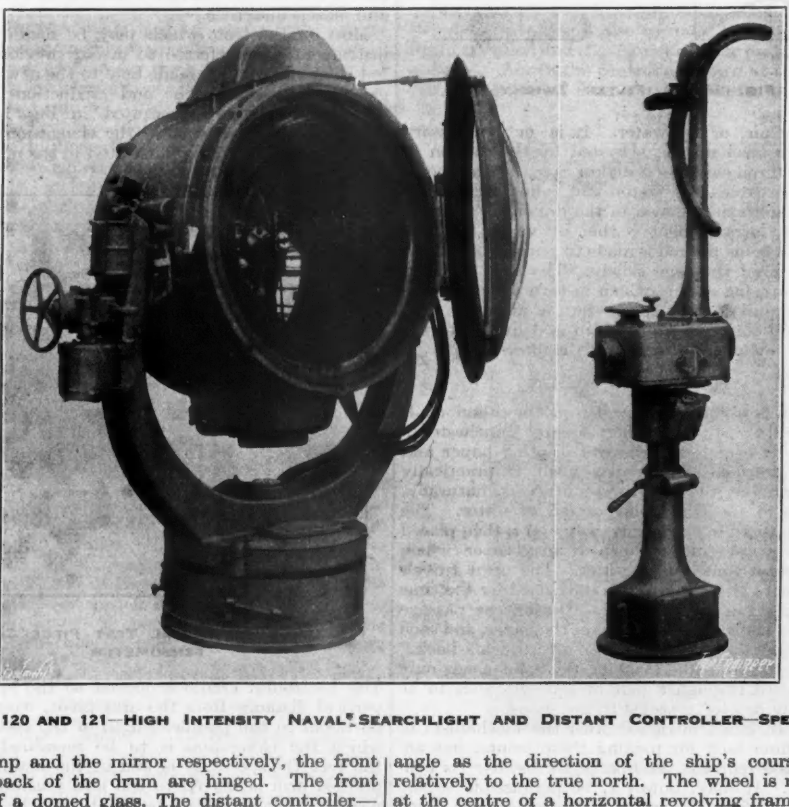
Captain Russell

With the increasing use of aluminium alloys in the construction of oil engines for electrical conductors and apparatus, and for light constructional parts generally, the necessity for turning the metal is frequently encountered. There was shown at Olympia, on the stand of Captain S. P. B. Russell, of Silverthorne, London-road, Camberley, a new "Alumalloy" tinning fluid, the use of which was successfully demonstrated in our presence, on rolled sheets and cast vessels. The results obtained appeared to be satisfactory as regards the interpenetration of the two metals, and where desired, tinman's solder was freely used once the metal was tinned. The covering capacity of the fluid is stated to be very large. The fluid is employed for the preparation of aluminium alloy connecting-rods and bearing shells for white metalling, while another use is for giving a protective coating of tin, in the case of aluminium alloy parts which are exposed to the action of sea water. With polished metal the use of a tinning fluid enables the parts to be chromium-plated.

On the same stand there was demonstrated an aluminium solder, which is used for filling up blowholes in castings, the repair of cracked castings, and the building up of lugs. It is known as "Alumalloy" semi-weld solder, and would seem to form a useful material for facilitating light metal construction and its repair.

The Sperry Gyroscope Company, Ltd.

A notable exhibit on the stand of the Sperry Gyroscope Company, Ltd., was the 36in. distant-controlled, high-intensity searchlight illustrated in Fig. 120. This searchlight is a naval pattern, and was constructed for a Portuguese sloop. It has a beam of 350 to 400 million candle-power intensity, and is constructed of a non-corrodible aluminium alloy. Its weight is only 1550 lb. Its range of movement extends from 100 deg. above to 20 deg. below the horizontal. The iris shutter, capable of being closed down to zero aperture, can be operated either by hand from a station at the searchlight itself, or electrically from the distant controller. The arc lamp is automatic in action, being fitted, to that end, with a thermostatic control. To give ready access to the lamp and the mirror respectively, the front and the back of the drum are hinged. The front consists of a domed glass. The distant controller—Fig. 121—is provided with two handles, one for elevating the searchlight, and the other for moving it in azimuth. The transmission from the controller to the searchlight is effected by a step-by-step electrical system, which ensures the immediate cessation of the movement of the projector simultaneously with the cessation of the movement of the control handle. A pair of binoculars mounted on the controller at a height adjustable to suit the stature of the operator, move in azimuth and in elevation in exact relationship with the movement of the searchlight beam.



Figs. 120 and 121—High Intensity Naval Searchlight and Distant Controller—Sperry

Among the other exhibits on the company's stand was an improved pattern of the Sperry-Villiers "Odograph." This instrument records to scale on a chart the actual course followed by a ship. The direction of the course plotted on the chart is controlled by impulses received at the instrument from the gyro-compass repeater transmission system, while the distance run is governed by impulses received from an electrical ship's log. In the original design of the instrument—illustrated herewith in Fig. 122—the chart is mounted on an iron-covered table, and over it there moves a wheel magnetised to adhere to the iron surface. This wheel is rotated on its axle by the impulses from the electrical log at a speed proportional to the ship's speed. At the same time it is controlled by the gyro-compass to turn about its vertical diametral axis. This control is such that the wheel is constrained to set its plane, relatively to the ship's longitudinal central plane, at the same angle as the direction of the ship's course bears relatively to the true north. The wheel is mounted at the centre of a horizontal revolving frame which is free to turn in azimuth with the wheel. This frame carries a pointer which reads against an external ring marked with the points of a compass card or in degrees. The north point of this external ring is constrained to tally with the north of the chart by means of a set of jointed parallel arms, clamped to the edge of the chart board, after the manner rendered familiar by the drawing office "drafting machine." The instrument as a whole is supported by a carriage mounted on castors. An arm, adjustable as regards direction, is clamped to the carriage, and on it a pencil carrier can be fixed at any desired point. The carriage, it will be gathered, is, by virtue of its attachment to the board by the jointed parallel arms, free to move to any point on the chart, the only constraint imposed upon it being that whereby the north point of its graduated ring is caused to tally at all positions of the instrument on the chart with the north of the chart. The movement of the carriage is governed by the movement, azimuthal and rotational, of the magnetised wheel within it. Initially, the direction of the magnetised wheel is set by hand into agreement with the ship's true course as given by the gyro-compass. This setting will be correct when the index on the frame surrounding and moving in azimuth with the magnetised wheel indicates the true course against the graduated ring. The pencil arm and carrier are simultaneously adjusted to bring the pencil point over the ship's position on the chart. Thereafter, the instrument will proceed to plot the ship's course without farther adjustment or attention. Provision is made whereby the operation of a drum divided to show inches to the mile enables the speed of rotation of the magnetised wheel on its axle to be varied to suit the scale of the chart. Provision is similarly made to allow for the change of scale with latitude in ocean charts.

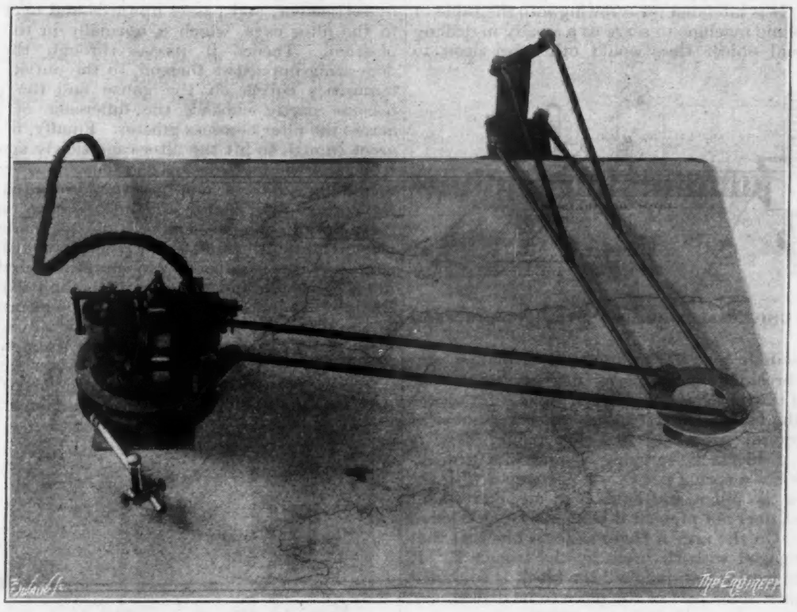


Fig. 122—Sperry-Villiers "Odograph"

This, the original, form of the instrument has been in use for a number of years. In the newer form, the first example of which was exhibited at Olympia, the magnetised wheel and an iron-surfaced chart board are dispensed with. The operating wheel is held down to the chart by weight instead of by magnetism. Another alteration consists in the grouping of the bulk of the mechanism at the clamped end of the parallel arm system, the operating wheel being moved by impulses transmitted out to it through conductors inside the tubes composing the parallel arm system.

E. L. Youngleson, Ltd.

Among the various workshop appliances shown on the stand of E. L. Youngleson, Ltd., 67, Chancery-lane, London, W.C.2, we were again attracted to the merits of the universal vice, of which we gave some description in our issue of May 12th, 1933. It will be remembered that this vice has the peculiarity that the front jaw is divided into two pieces, each of which is mounted on a swivelling stalk, so that the gripping faces may accommodate themselves to the object

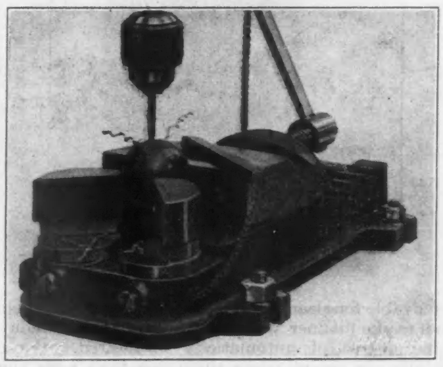


Fig. 123—Machine Vice—Youngleson

to be held. We gave this vice somewhat of a test in holding an old half-penny—it was of Victorian mintage, and consequently had a rounded edge. The vice held it so securely that we were able to file off the minting impression without the coin once jumping out.

There was also a recent development of the same vice for machine table service, of which we give an illustration in Fig. 123, which shows how it is adapted for bolting down to the table. It should prove very useful in many tool-room jobs.

A handy little gadget on this stand was the universal drilling stop, represented by the sketch, Fig. 124. It is intended for screwing into the table of a light drilling machine to serve as a steady in drilling some casual object that would otherwise need to be held securely by hand to prevent it wobbling, and possibly breaking the drill as it emerged at the bottom of the hole. It comprises a pillar A for screwing into the table, which is turned with a number of circumferential grooves. On this pillar there is mounted a block B carrying a rack-like arm F. The block has a spring peg C, which engages with the grooves in the pillar, and holds it at any convenient height, but does not prevent it being raised or lowered by hand. On the arm F there slides a block D that can be engaged with the rack by the trigger E. It is a simple matter to "juggle" the block D so that it bears against some part of the piece to be drilled, and thus prevents its accidental movement.

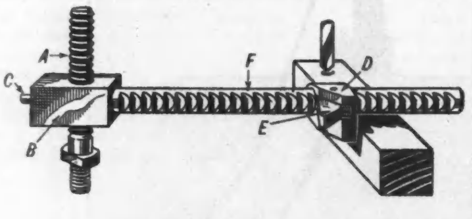


Fig. 124—Universal Drilling Stop—Youngleson

Zwicky, Ltd.

As engineers produce mechanisms to closer and closer tolerances, and to work with finer and finer clearances, the importance of the suitable filtration of oils, both lubricating and fuel, and other liquids becomes greater. This matter breeds problems of its own, for while in the days when only comparatively coarse filtration was required, a filter that was removable for cleansing by hand in a somewhat rough and ready manner was no disadvantage, nowadays some degree of automaticity is desired. Consequently, in recent years there has been very considerable development of semi-automatic and completely automatic self-cleaning filters. One of the most ingenious and effective of these devices was to be seen on the stand of Zwicky, Ltd., of Slough, and is illustrated in the line and tone engravings, Figs. 125 and 126. Use, in this filter, is made of the increased pressure difference brought about by the collection of impurities in the gauze to cause the mechanism to operate and set in action for a short interval a reverse flow. For this purpose the filter gauze cage D is mounted on a vertical rod having axial movement. A spring toggle gear acts on this rod. In the engraving it occupies its top position, and it will be seen that the springs of the toggle gear tend to retain it in that position. The arrangement is such, however, that in the bottom position the toggles are inclined at an angle slightly below the horizontal and therefore tend to retain the cage in that position also. Stability, in fact, is only obtained when the cage is in either its top or its bottom position. Entering the inlet chamber through the pipe A the liquid, owing to the sudden enlargement, deposits its grosser impurities by settlement, and passes upwards and over a baffle to the filter cage, which is normally in the bottom position. Thence it passes through the gauze, depositing impurities thereon, to the outlet. As the impurities collect on the gauze and the passages become partly choked, the difference of pressure across the filter becomes greater. Finally, it becomes great enough to lift the filter cage slowly against the springs of the toggle gear. As soon, however, as the toggle limbs have swung past the horizontal position the springs take charge and lift the cage rapidly to its top position. This action, while not hindering the general flow of the fluid through the apparatus, causes a temporary reversal of flow to occur through the gauze filter. Dirt is swept off, past the baffle valve B, into the internal chamber C, whence on the return motion of the filter cage it passes through a valve into the main sump for removal at intervals through a drain plug or cock.

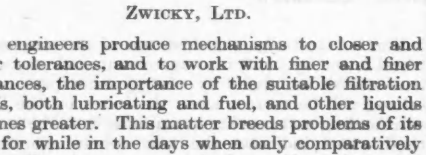


Fig. 125—Oil Filter—Zwicky

The resetting of the filter cage in the lower position may be performed by hand, by a mechanical gear, by steam, by air, or by water. It is only necessary to arrange mechanisms, actuated by the motion of the vertical rod carrying the filter cage, for the operation of the valves of a piston and cylinder construction similar to that shown in the drawing. Perhaps the neatest arrangement is that by which the flow of the fluid being filtered is made to generate sufficient power to reset the cage slowly. The fluid drives a rotor E carrying a cam, which in turn drives a little plunger pump with a spring return motion. This little pump compresses air which is delivered to the "return" cylinder on the top of the filter casing.

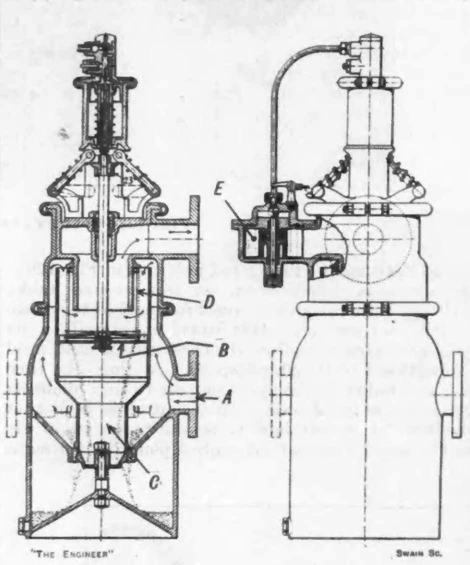


Fig. 126—Oil Filter—Zwicky

J. Halden and Co., Ltd.

There was a distinct novelty on the stand of J. Halden and Co., Ltd., 8, Albert-square, Manchester,2. in the form of a ferro-prussiate printing paper and printing process. The paper itself is practically waterproof, but the sensitised surface is, naturally, amenable to the developing action of water. The paper is printed in the normal way and is then placed face downwards on a sheet of glass over which there flows a thin film of water. The print travels forward with the water and is developed by the time it has passed across the glass. During the passage very little water gets on the top of the paper, and such as does trickles off "like water off a duck's back." On emerging from the machine the print needs only to be passed through a pair of squeegee rolls to be sufficiently dry to be issued to the shops.

We were much intrigued with the mechanism of the machine used for making these prints, but are not, at the moment, at liberty to disclose its construction. It may, however, be permissible to say that the surface formation of the glass over which the water and the print pass is of considerable importance.

Another machine on this stand which, in essence, involves the same principle of avoiding the unnecessary moistening of the fibres of the printing paper is the Dynalator, for making dye-line prints. It is little more than a trough, into which there dips a roll of stainless steel. Above there are two rubber-coated rolls. The exposed print is passed between these rolls and picks up, from the stainless roll, just sufficient of the developer to make a good print. The machine is arranged either for a simple hand drive, on the end of the main roll, for occasional use, or for an electrical drive for continuous service.

Tensometer, Ltd.

On the stand of Tensometer, Ltd., of 73, Southampton-row, London, W.C.1, there was shown a complete range of the Hounsfield tensometer, which was fully described and illustrated in our issue of February 17th last.

The full range of test pieces which have now been standardised includes eight different test specimens, embracing five different cross sections, which vary from one-hundredth to one-seventh of an inch in area. These, it is claimed, provide a suitable range for tensile tests from 200 tons per square inch downwards. The elongation is measured over the heads, and therefore the parallel length between fillets has a standard ratio to diameter of 3·544, with the exception of two special test pieces used for cast aluminium and plastic materials.

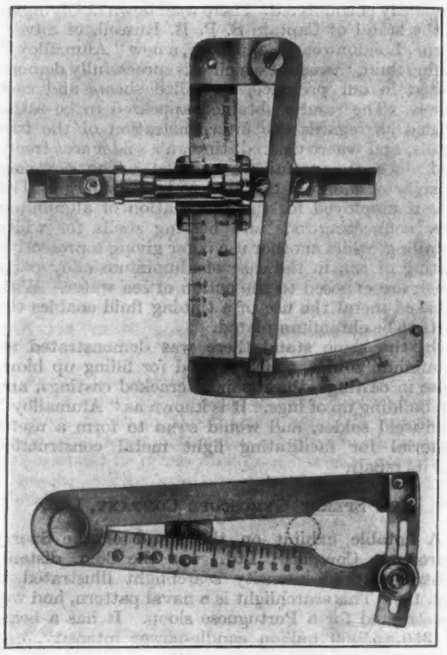


Fig. 127—Elongation and Reduction Gauges—Tensometer

Most of the tests which may be made with the instrument were referred to in our previous article, but reference may be made here to the new universal gauges for elongation and reduction in area per cent. which are illustrated in Fig. 127. The former is designed to show the elongation per cent. of all test pieces and is illustrated in the upper view.

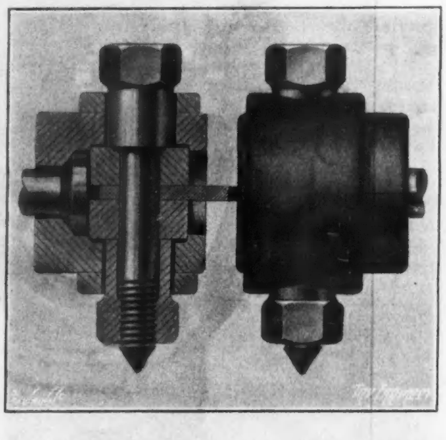


Fig. 128—Sheet Metal Test-Piece Chucks—Tensometer

The horizontal cradle is locked at the appropriate vertical distance from the arm pivot, which is proportional to the parallel length of the test piece on which the elongation is to be measured. Before the test the specimen is laid in the cradle and the pivoted arm is moved to the left, pushing the test piece and left-hand slide before it until the arm reads zero. The left-hand slide is then locked, and after pulling the specimen the two ends of the broken test piece are lightly pressed against the left-hand slide stop by the arm, whose new reading is the elongation per cent.

The reduction in area gauge illustrated in the lower part of Fig. 127 is also a universal gauge, and applies to all test pieces. Before test the unbroken specimen is placed at the zero reading indicated by the dotted circle, and the two arms are closed to touch it, and are then locked. After the test a broken end is slid towards the pivot and the reading at which both arms touch it is the reduction in area per cent. Illustration Fig. 128 shows the very simple form of split chuck with embracing collars and screws, which is utilised for pulling the strip test specimen in a similar way to the tensile test. In order to prevent any previous work hardening of the piece which might take place through punching out the specimen, drilling and filing jigs are provided. The firm has also introduced a simple hatchet form of planimeter for rapidly determining the impact value from the diagram of the notched bar test.

Alfa-Laval Company, Ltd.

A very necessary part of the equipment of the modern liner and motor ship is the centrifugal oil purifier, which also finds a place in many oil engine and power station equipments. On the stand of the Alfa-Laval Company, Ltd., of 34, Millbank, London, S.W.1, there was shown a very complete range of centrifugal oil purifiers. Interest was attached principally to the company's new marine type purifier, which is illustrated in Fig. 129 herewith. While retaining some of the features of the original de Laval, many improvements, based on long service results, have been embodied in the new design. These include new features to increase the self-cleaning properties of the bowl, which can now be sludged out with a flow of water and run dry. The renewable wearing parts of the spindle have been reduced to four, and the spindle is lubricated by a hand-operated pump. Fig. 129 shows a direct-coupled motor-driven machine, but totally enclosed motor-driven machines and belt-driven machines can also be supplied. The international character of the Alfa-Laval company's business and its after-sales service organisation in the principal world ports are factors of considerable importance to shipowners and marine engineers.

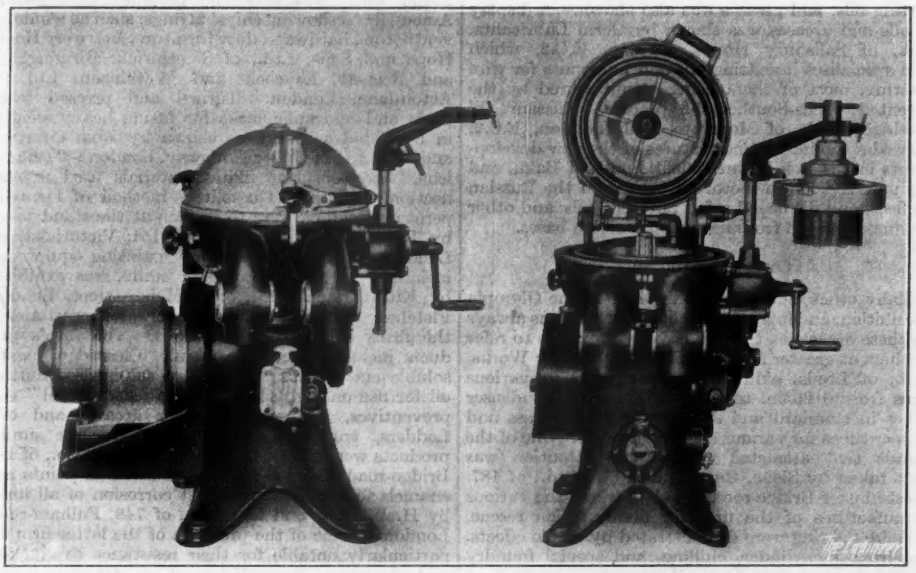


FIG. 129—MARINE TYPE OIL PURIFIER—ALFA-LAVAL

Alexander Stephen and Sons, Ltd.

One of the principal exhibits on the stand of Alexander Stephen and Sons, Ltd., of Linthouse, Glasgow, was a model of the new Stephen three-cylinder compound marine steam engine, which has been designed and built by the company to embody the results obtained from the engines of the s.s. "Annan," which were described in our issue of August 19th, 1932. The high-pressure cylinder valves are of Andrews and Cameron design, and are hydraulically operated, while the two low-pressure cylinders are of the uniflow type. The saving in weight and length of the engine compared with the standard triple-expansion design is, we are given to understand, about 20 per cent. The first engine of this type is now erected and about to undergo exhaustive tests.

George Kent, Ltd.

The principal exhibit of George Kent, Ltd., of Biscot-road Works, Luton, Beds., was automatic boiler control apparatus, arranged on panels to give a clear idea of the nucleus of the two systems which the firm has developed. The Kent electrical system is most suitable for generating station steam-raising plant and large water-tube boilers generally, whilst the firm's hydraulic system is applicable to all industrial boiler plants, and especially batteries of Lancashire boilers. In the master controller of the electrical system, the "gradient analysing" type of control is applied to the balancing of the load with the heat input to the boilers. The steam pressure is measured by a continuously rotating piston which has the pressure applied to its underside through an oil seal. Most of the force is balanced by the deadweight, and light springs make it take up a position proportional to the pressure. The sensitivity is in the neighbourhood of one-tenth of 1 lb. per square inch at 400 lb. per square inch, and the total range of movement can be made to correspond to a variation of only plus or minus 5 lb. per square inch. The movements of the piston are conveyed to two contact arms, one of which receives the motion directly and the other through a friction clutch. Secondary contact arms approach the primary arms at suitable speed and give a length and direction of contact with each primary arm depending on its distance from its central or normal position. The directly coupled arm therefore gives signals depending on the deviation from the correct pressure, while the indirectly fixed arm, which is pushed to the centre at each cycle by the contacts, gives signals depending on the amount by which the pressure has changed since the last cycle, or on the rate of change of pressure.

The profile of the cams which move the secondary arms determines the curve relating the return of the pressure to the correct value, and an adjustment is provided by which the steepness of the curve can be set to suit any installation or condition. The complete installation also includes the furnace pressure controller, and the regulating gear for the draught and fuel. Above the controller shown at the Exhibition, there was an illuminated indicator to show the way the controller was influencing the factors governing the rate of evaporation. Embodied in a panel adjacent to the one for the electrical system was the master controller for the Kent hydraulic boiler control system, which is of simpler construction, and, as we have said, more applicable to industrial boiler plants.

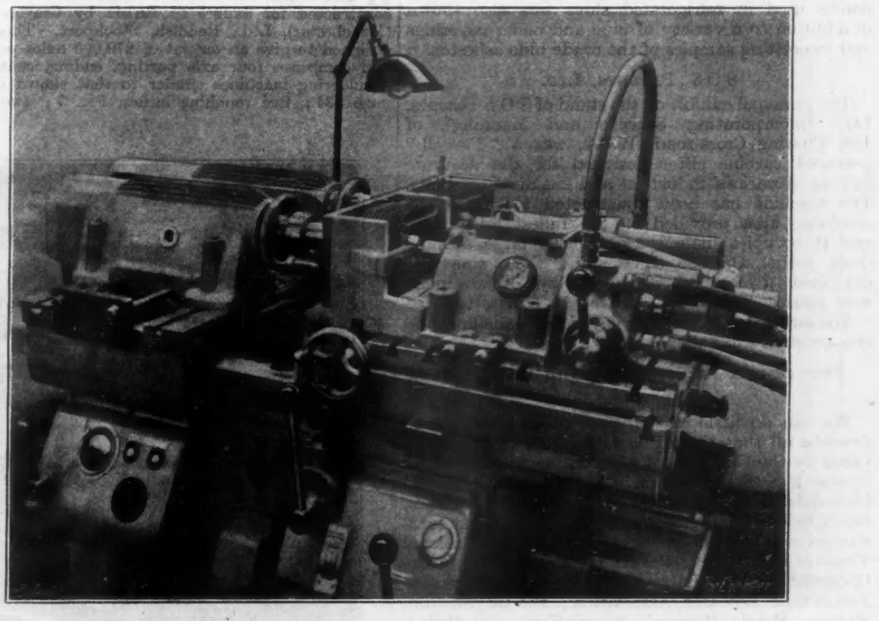


FIG. 130—VOMAG TWO-SPINDLE PRECISION TURNING AND BORING MACHINE

Another exhibit was the fuel air ratio controller, employed to measure the air supply and to adjust the fuel feed accordingly. There was also a model of an air duct containing a damper and operated by a power cylinder, controlled through its distributing valve from the master controller on the panel. Such a power cylinder used with the hydraulic system can either be employed to adjust the position of dampers or to move brush shafting gear on A.C. commutator motors driving fans.

Machine Tools.

There was as usual a fine display of machine tools, mostly of foreign origin, arranged in the annexe to the main hall. The exhibits of Selson, Ltd., and Schiess-Defries (Great Britain), Ltd., have already been described. Other firms showing machine tools were E. H. Jones (Machine Tools), Ltd., of Islington, London; Dowding and Doll, Ltd., Greycoat-street, London; Leo. C. Steinle, Ltd., of 81, Marsham-street, London, and Soag Machine Tools, Ltd., of 45, Horseferry-road, London. Many of the tools on each stand were shown actually in operation, so that visitors could see for themselves the accuracy of the work produced and the methods of operation. Notable on the stand of E. H. Jones, Ltd., were the "Gyromatic" automatic lathes, made by the Tavannes Watch Company, of Switzerland, and described in The Engineer on June 9th last. A Thiel vertical punch and form shaper attracted a good deal of attention. The sketch reproduced herewith in Fig. 131 illustrates the sort of job with which it can deal. In order to obtain the motion the tool holder is mounted on a substantial block forming a sort of crank between two bearings, so that it may be rocked over by a suitable mechanism at the correct point in the stroke. The Werner milling machines on this stand also made a good show.

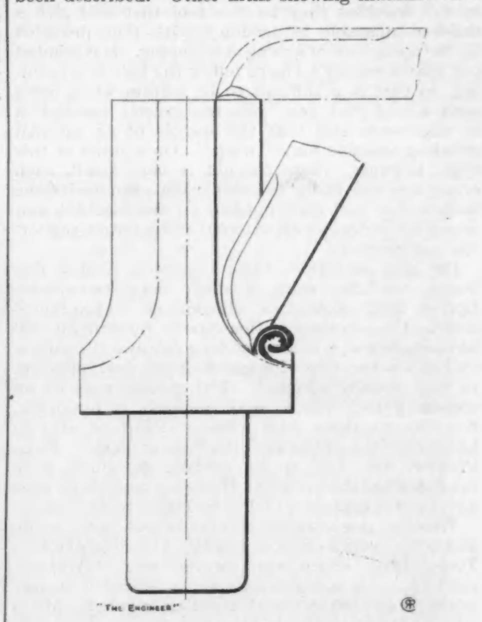


FIG. 131—ACTION OF THIEL SHAPER

A Heller vertical cold sawing machine on the Leo. C. Steinle stand was attractive. It is intended for cutting rolled sections either square or at an angle, and the saw itself is mounted in a cage that may be swung through 360 deg. A flange motor mounted on the saw carriage drives the blade, and the table is in the form of a self-centring vice so arranged that the work is always held under the middle of the saw blade. Longitudinal motion of the table is available for setting the blade to the height of the gripping jaws ready for the cut, and for adjusting the work according to the marking off. The Vomag precision finishing machines, with two and three spindles respectively, exhibited, are intended for use with diamond or tungsten carbide tools upon the finishing of holes. The distance between the spindles is adjustable so that work may, for instance, be carried out simultaneously on the big and little ends of a connecting-rod. The feed is hydraulic. A two-spindle machine is illustrated in Fig. 130. The makers believe that in this machine they have a tool that will give a finish comparable in accuracy with that provided by the operations of honing and lapping. It is pointed out that a reamer tends to follow the hole it is reaming, so that it is difficult to be certain when using such a tool that two holes are exactly parallel or in alignment, and that the spindle of an internal grinding machine may "whip." On a lathe of this type, however, where the cut is very small, such errors are not likely to arise. We examined some bushes that had been finished on the machine and found the surface, both external and internal, mirror-like and accurate.

Dowding and Doll, Ltd., besides a Krause fine boring machine, using a single tungsten-carbide-tipped tool, showed a Magdeburg "Chip-flow" lathe. The principle of this type of machine, it will be remembered, is to arrange for a downward-pointing tool and a direction of rotation of the work opposite to that usually adopted. The spindle runs at an unusually high speed, and the feed is hydraulic. Familiar to those who make a habit of visiting Leipzig are the products of the Pfauter works. Three Pfauter gear and spline hobbing machines were exhibited on the stand at Olympia, and there were also several examples of Pittler lathes to be seen.

Welding machines of several types—spot, seam, and butt—were to be seen exhibited by Soag Machine Tools, Ltd., which also showed some "Wotan" products, a heavy-duty shaper, a precision surface grinder, and an internal grinding machine, all of which were hydraulically operated.

THE CAPE ASBESTOS COMPANY, LTD.

An interesting exhibit on the stand of the Cape Asbestos Company, Ltd., of 26, Holborn, E.C.1, was an electrically heated steam pipe of 4in. bore with a length of 4ft., which was covered with a layer of "Bandall-Caposite" insulation and maintained at an internal temperature of 600 deg. Cent. The outer covering was only warm to the hand, and demonstrated the effective insulation provided by blue Cape asbestos, which, it is claimed, is one-third lighter than magnesia coverings. In collaboration with Donald Bean and Co., Ltd., of Glasgow, an illustration was shown of a ship's cabin which was fitted on the outside with "Bandall" cement-faced blue slabs, and was lined with fireproof plywood panels on the inside, showing the construction adopted for a mid-section of the ship just above the water line, and the method of covering beams and knees, and of giving access to adjoining spaces where necessary. Examples of the special washable panels used in refrigerated ships was also shown in addition to a variety of pipe and boiler coverings and interesting samples of the crude blue asbestos.

S O S PATENTS, LTD.

The principal exhibit on the stand of S O S Patents, Ltd. (incorporating Stevens and Manning), of 156, Charing Cross-road, W.C.2, was a "Pascall" patented turbine sifter designed for the accurate sieving of various industrial and chemical products. The machine has been constructed to utilise the screening area provided to the fullest advantage, and it occupies little space for the large outputs dealt with. On the same stand there was also exhibited a comprehensive display of strainers, wire gauzes, and sieves, as well as a new type of "Artmarble," which is employed for panelling and construction work aboard ship.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

We can do little in the space at our disposal to describe all that there was to be seen on the stand taken by the Department of Scientific and Industrial Research at the Exhibition. Anyone who has had in his hands the annual report of any one of the bodies, listed below, that co-operated to make the stand a success will appreciate our difficulty. The National Physical Laboratory; the Fuel Research Station; the Chemical Research Laboratory; the British Scientific Instrument Research Association; the British Non-Ferrous Metals Research Association; the British Cast Iron Research Association, and the Industrial Research Council of the National Federation of Iron and Steel Manufacturers, all displayed representative objects illustrating the lines upon which their respective works were proceeding. In the circumstances, we do not intend to attempt any description whatever, but only to welcome the enterprise of the research bodies in taking so much space at the Exhibition. In this way many of those who otherwise can only derive their instruction from the printed records of the research work were enabled to see for themselves the actual specimens, models, or graphical conclusions. The stand, indeed, had an atmosphere quite foreign to that of the others. There was about it that air of quiet undisturbed study so noticeable in a laboratory, and imagination almost cheated the visitor into believing that it was quieter there than elsewhere in the Exhibition hall. The attention it received will, we hope, encourage the Department to take space on other occasions.

THE OIL COMPANIES.

At an exhibition in which oil engines played so important a part, it was not surprising to find a good representation of oil-producing interests. On the stand of Shell-Mex and B.P., Ltd., of Shell-Mex House, the Strand, London, W.C.2, were shown samples of their different grades of fuel for internal combustion engines. These included "Shell Diesel Oil," for marine and industrial oil engines; "Gasoleum," for the smaller types of engine, and "Light Diesoleum," for high-speed compression-ignition engines. A wide selection of lubricants, cutting oils, and greases was also shown.—A display of oils and greases was shown by Germ Lubricants, Ltd., of Salisbury House, London, E.C.2, which firm specialises in cutting oils and lubricants for wire drawing, most of them being manufactured by the patented Wells-Southcombe process.—Russian Oil Products, Ltd., of Moorgate Hall, London, E.C.2, showed some interesting pictures of the new developments in the Lok Batan oilfield, South of Baku, and the new 10,000-ton motor oil tankers of the Russian oil fleet, and displayed a full range of oils and other products derived from natural petroleum bases.

OTHER EXHIBITORS.

Many other makers also exhibited at the Olympia Exhibition, and it is a matter of regret to us, as always on these occasions, that we have been unable to refer to them at greater length. Yorkshire Copper Works, Ltd., of Leeds, exhibited copper tubes in various sizes from 0·005in. to 24in. in diameter, condenser tubes in standard and special alloys and brass and copper tubes for various special purposes. One of the stands that attracted considerable attention was that taken by Siebe, Gorman and Co., Ltd., of 187, Westminster Bridge-road, London, where the various manufactures of the firm for diving, mine rescue, and fire fighting were demonstrated by scenic effects. Pig irons in cylinder, chilling, and special foundry qualities were exhibited by British Pigirons, Ltd., of Abbey House, Victoria-street, London, a firm which claims to be a pioneer in Great Britain in the supply of pig iron to a definite guaranteed analysis, coupled with the appropriate fracture. That ingenious instrument, the electro-magnetic crack detector, which we have described on previous occasions, was shown by the Equipment and Engineering Company, Ltd., of 2 and 3, Norfolk-street, Strand, London, and among other firms exhibiting whose products or processes must be familiar to readers of THE ENGINEER were British Dardelet Threadlock, Ltd., of Chase-road, London, whose works we described as recently as August 18th last, and Fescol, Ltd., of 101, Grosvenor-road, London. With so fine a display of oil engines as that at Olympia, it was to be expected that firms such as Wellworthy, Ltd., of Lymington, Hants, and the Clews Petersen Piston Ring and Engineering Company, Ltd., of Mill-lane, West Hampstead, should show their piston rings of various types. Packings of various kinds of "Lion" brand were exhibited by James Walker and Co., Ltd., of Woking, the principal types being "Block Steam," "Expanding Steam," and "Automatic Water," for steam and hydraulic work, "Emerald" packing for expansion glands, and "Sturntite" for propeller shaft glands. Among firms showing ships' fittings, such as windows, ventilators, hardware, door furniture, &c., were Henry Hope and Sons, Ltd., of Smethwick, Birmingham, and Beckett, Laycock and Watkinson, Ltd., of Acton-lane, London. Turned and pressed metal parts and hydraulic jacks for lifting heavy weights in restricted spaces were shown by Ross Courtney and Co., Ltd., of Upper Holloway, London; "Chameleon" oxy-acetylene filling materials used in connection with the "Gussolite" method of low-temperature welding, were to be seen at the stand taken by Thorn and Hoddle, Ltd., of 151, Victoria-street, London; and some neat spray painting equipment, including portable compressor units, was exhibited by Kurt Erlach, Ltd., of 2, Melior-street, London. Fletcher, Miller, Ltd., of Manchester, was among the firms exhibiting special oils. The firm's products include "Cooledge" and "Clearedge" water soluble cutting oils, "Swift," a sulphurised cutting oil for use on high-speed automatics, "Rodol" rust preventives, and various other greases and oils. Ladders, trucks, scaffolding, and various similar products were shown by Drew, Clark and Co., of Lea Bridge-road, London; and specimens of paints and enamels for protection against corrosion of all kinds by H. Windsor and Co., Ltd., of 748, Fulham-road, London. Some of the products of the latter firm are particularly notable for their resistance to cracking and abrasion. Rangefinders of several types and a display of binoculars for all sorts of purposes were shown by Barr and Stroud, Ltd. "Bettaskaf" steel tubular scaffolding was exhibited by Burton, Delingpole and Co., Ltd., of Old Hill, Staffordshire.

Railway Axle Plant for Russia.

AN interesting plant for machining railway carriage and wagon axles on a vast scale has recently been constructed for export to Russia by Craven Brothers (Manchester), Ltd., Reddish, Stockport. This plant is designed to give an output of 270,000 axles per annum, and comprises four axle parting, ending, centring, and shouldering machines similar to that shown in Fig. 6, page 334; five roughing lathes, Fig. 7; two finishing machines, Fig. 8, and four journal grinding machines, Fig. 1. The equipment of these machines embraces many features which have hitherto been mainly used on small automatic machines. These features have been included in order that the machines can be operated by semi-skilled or, possibly, by unskilled workpeople.

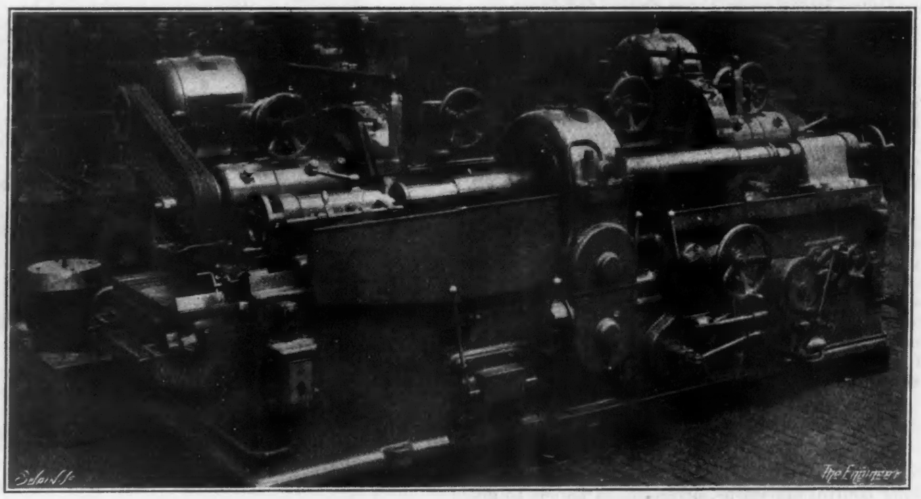


FIG. 1—DOUBLE-ENDED GRINDING MACHINE

The double-ended, centre-driven type of machine tool is specially suited to the machining of railway carriage and wagon axles, and it will be noted that a centre-driven headstock is a feature common to all the machines illustrated. This type of drive for axle lathes is, of course, not new. Applied to machines having multiple tooling and semi-automatic tool slide operation it gives a greatly increased output. The design of the machines has also been influenced by the intention to make use of cemented tungsten carbide cutting tools, which necessitated great strength and rigidity of the parts, and the use of ball and roller bearings and pressure oiling systems to allow of high speeds and maintenance of accuracy of alignment.

PARTING, ENDING, CENTERING, AND SHOULDERING MACHINE.

The parting, ending, centering, and shouldering machine illustrated in Fig. 6 performs the preliminary operations before the axles are placed in the roughing lathe, and although these operations appear at first sight to be simple enough, they involve the use of a number of tools

—see Fig. 2. There are the front and rear parting tools at each end and the tools for cutting out the radiused portion of the journal, mainly to assist in the subsequent machining operations. The operations of drilling and centring the axle are then performed automatically. The sequence of the operations carried out on this machine is as follows:—The axle, being placed in the centre V support, the headstocks with their slides are traversed quickly along the bed, bringing the cutting tools to the correct position for parting the axle. The control for these heads and slide traverse is by means of push-buttons, and the operation of placing the axle on the V supports and adjusting the heads is carried out in approximately two minutes. The jaws of the concentric chucks are then tightened on to the axle also by means of push-buttons.

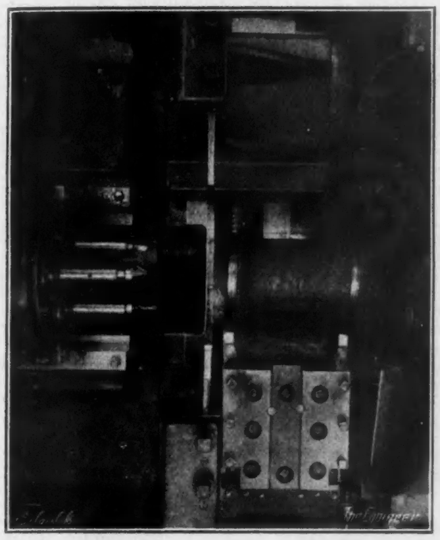


Fig. 2—Tool Lay-Out on Axle Parting Machine

After the axle has been gripped at both ends, a lever centrally placed on the lathe is moved to the starting position, which immediately sets the machine in motion and causes the front and rear tool slides to approach the axle rapidly, after which the feed is automatically engaged. While the ends of the axle are being parted the grooving tools on the front slide are also engaged. These have a traverse of about an inch during the cutting operation, after which they automatically return to the starting position whilst the parting tools continue to traverse. On the completion of the cutting operation the pieces cut from the axle fall into trays provided for the purpose, the tool slides returning automatically to their starting position. It should here be mentioned that during the cutting operation the speed of cutting automatically increases as the tools approach the centre of the work, and during the quick return of the slides the speed automatically changes to the low or starting speed. The main spindle is then stopped by a push-button and the drilling heads, which are also controlled by push-buttons, are set in motion. There are three spindles in a circular form of turret to each tool slide, the first being provided with a cutter which removes the pip left on the axle from the parting operation. This provides the centre for the second spindle which performs the high-speed drilling operation. When the drilling is complete the coning drill spindle comes into operation, finishing the complete centre at both ends of the axle. The drill heads are fed and indexed automatically and when the centering operation is complete they stop automatically.

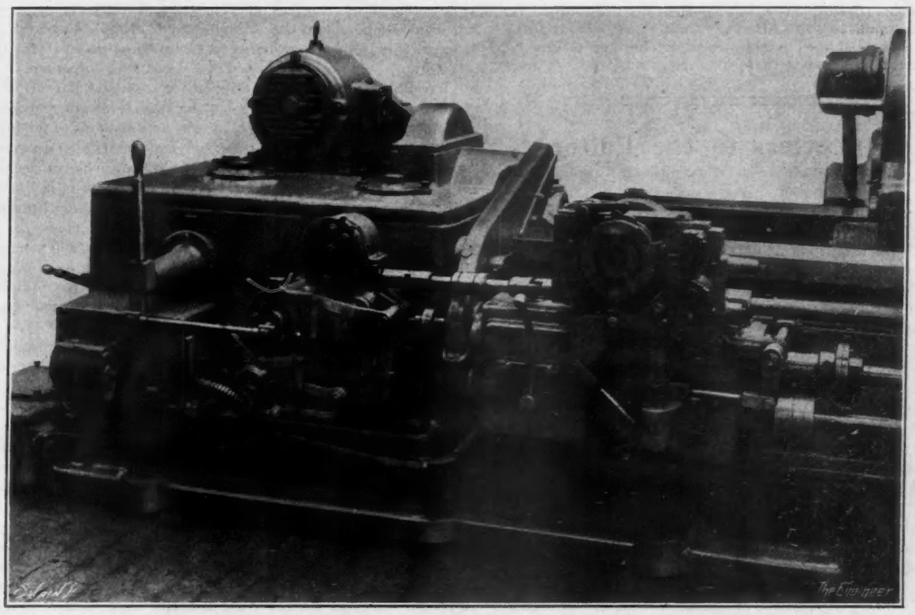


Fig. 3—Tool Slide and Automatic Controls on Parting Machine

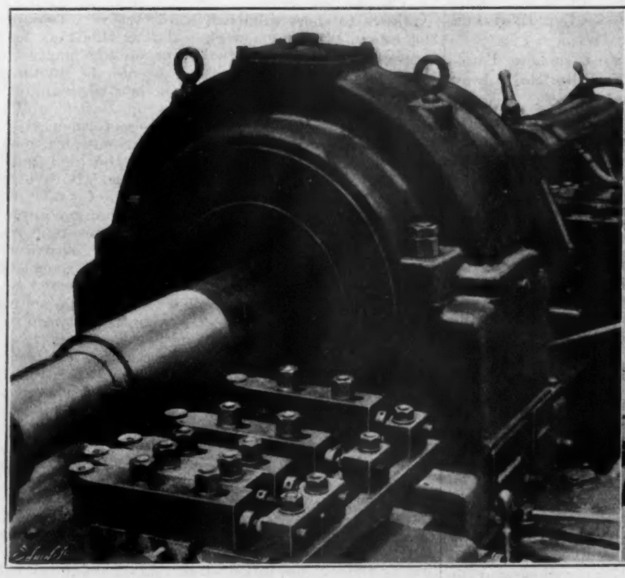


Fig. 4—Tool Lay-Out of Roughing Lathe

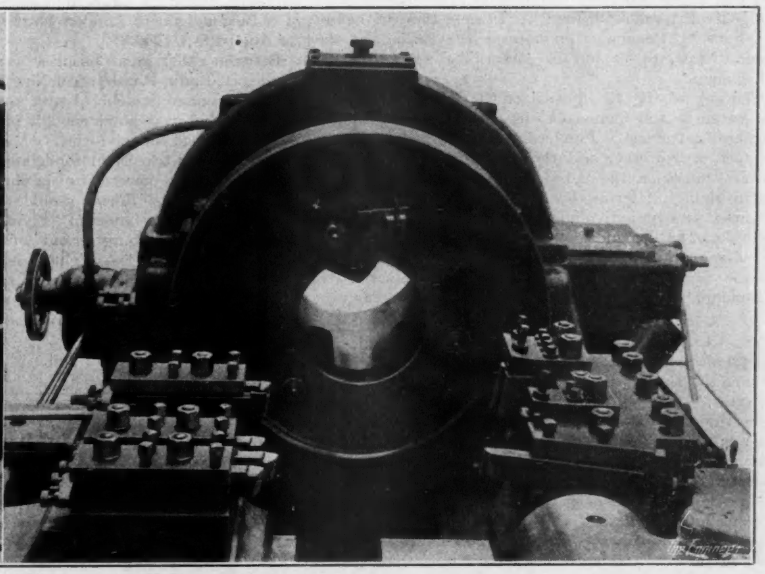


Fig. 5—Tool Lay-Out of Finishing Lathe

The axle is then ready to be released. The chucks are opened by push-buttons, and the headstocks and slides are traversed towards the ends of the bed to enable the axle to be lifted clear. The complete series of operations is effected in eight minutes without any heavy manual effort. There are six electric motors on the lathe, together with the necessary switchgear and control system, and the push-buttons and main control lever are centrally placed for easy access. Fig. 3 shows the controlling mechanism for the automatic operation of the tool slides and the speed change mechanism. It may be mentioned that where it is necessary to use A.C. constant-speed motors, the changes of speed are obtained by friction clutches, but where D.C. supply is available the variations in speed are obtained from a variable-speed motor, the change being adjusted electrically. In both cases the speed changes are controlled automatically by the position of the tool slides. This lathe weighs 19½ tons.

Axle Roughing Lathe.

The axle roughing lathe on which the next series of operations is performed is shown in Fig. 7, and its tool equipment in Fig. 4. The duty of this lathe is to rough turn the journals and wheel seat portion of the axle. The grooves machined during the preliminary operation greatly assist in the adjustment of the tools for depth, so that the longitudinal traverse can start immediately. This lathe is of the semi-automatic type, the tool slide and saddle movements being both automatically controlled from the central control mechanism. Thus when the axle is in position in the machine a lever is moved which causes the tool slides to approach the axle quickly, after which the longitudinal control lever is operated and both saddles and their tools are traversed lengthwise along the axle, turning the various diameters simultaneously. Upon completion of the cut the saddles return to their starting position automatically and the tool slides are rapidly withdrawn from the axle. The tools are all controlled from one central position.

The centre driving spindle is mounted on ball bearings, and the drive from the spindle to the axle consists of a floating type of driver which automatically takes up engagement. The right-hand tail-stock is mounted on a transverse slide, which is provided to enable the axle to be readily passed through the centre head-stock spindle to its correct position. The movement of the tail-stock on its slide is controlled by a push button for rapid adjustment. The tail-stocks are provided with special live centres of heavy design, and the spindle speeds provided enable either ordinary high-speed steel or tungsten carbide tools to be used. The tools are supplied with coolant and all cuttings fall clear into trays below the bed. The main drive is taken by a 60 H.P. motor, and the machine is capable of performing all its turning operations on a 7in. axle in ten minutes "floor to floor" time. Its weight is 14½ tons.

Axle Finishing Machines.

The finish turning operations are performed on the lathe shown in Fig. 8, which is very similar in design to the roughing lathe, except that it has rear tool slides which are automatically operated and are arranged with tools for accurately finishing the shoulders and radii, as seen in Fig. 5. As these tools are never disturbed after being once set up, the accuracy of the various shoulder positions is maintained. The front saddles, provided with tungsten carbide tools for finishing cuts, are entirely independent of the rear in-cutting slides. When once the axle is placed in position and the driver is adjusted the tools are advanced forward to the correct cutting diameter, and the longitudinal feed is engaged. In both saddles this motion is controlled by one lever. A very high cutting speed is obtainable for the use of alloy tools. When the traverse is completed the slides automatically return to the starting position, at which point the operator engages the rear tool traverse mechanism, which causes the tools to approach the axle quickly and automatically, and when the correct depth is attained the feed is automatically engaged. To enable high speed forming tools to be used on the machine after using tungsten carbide tools for the turning operation the speed is automatically reduced, thus mitigating the possibility of damaging the tools by the use of the wrong speeds. When the rear tool-cutting operations are completed the tool slides return automatically to their starting position, during which time the spindle speed is again automatically changed back ready for the first operation. The complete range of operations on this lathe occupies 15 minutes. The machine is driven by a 20 H.P. motor and weighs 12¾ tons.

Grinding Machines.

During the finishing operation material can be left on the journal or wheel seat for a final grinding or burnishing operation, although with tungsten carbide tools the finish obtainable is such that these operations are superfluous. If it is preferred to grind the journals for the "final finish," the double-ended grinding machine shown in Fig. 1 is provided. This machine is also of the centrally controlled semi-automatic type, with two independent grinding heads controlled by one lever at the front of the machine. The grinding heads are provided with hydraulic transverse motion for traversing the grinding wheel quickly to and from the work. Both grinding wheels are mounted on one saddle with longitudinal traverse and operate simultaneously on the journals. An interesting point in this connection is the provision of a traverse mechanism, which enables the complete journal right up to the radii and shoulder of the axle to be ground without any adjustment. The in-feed of the wheels is automatic, and when their work is completed the grinding heads are traversed clear to allow the free positioning of the next axle. The axle is driven from the centre hollow spindle driving head by means of a floating driver, and special micrometer direct-reading caliper gauges are provided at each end of the machine for checking the ground journals. These gauges are always in position, and if it is found that one grinding wheel wears more than the other, resulting in a difference in the diameters of the two journals, a simple correcting adjustment is made. Diamond truing devices are fitted on each tail-stock for imparting the true shape to the wheel. The operations on this machine can be carried out in 12 minutes.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SCIENCE AND PROGRESS.

Sir,—Your leading article on Sir Josiah Stamp's address, "Must Science Ruin Economic Progress?" is most admirably chosen. For anyone so eminent to suggest that in any circumstances "the world might be better served in the end if scientific innovation were retarded" in any degree at all is indeed ominous. Following closely on the warning to technicians contained in a letter in your previous issue that "they may yet find such activities as the discovery and invention of improved productive processes indicted as criminal offences against the community," these words of Sir Josiah Stamp are strangely like the writing on the wall.

Your are therefore most heartily to be congratulated on taking the stand that "it is not innovation that is at fault, but rather that . . . purchasing power has not advanced *pari passu* with producing power." That, Sir, is a challenge to Sir Josiah's conclusion that there must be "large infusions of social direction" (restriction of scientific innovation?) "and internationalism" (of which the latest example, the world wheat agreement, is a measure for restriction of production to effective demand, *i.e.*, purchasing power). At every stage in the development of Sir Josiah Stamp's most illuminating discourse we find that the dilemma is one of "Money *versus* Man," as Sir Frederick Gowland Hopkins has it, or of "Money *versus* Action." Money, credit, purchasing power; wages, profits; costs, prices; all these are the factors, purely financial, which affect decisions. Occurring repeatedly in nearly every paragraph of his address they point unmistakably to the conclusion which you have drawn.

May I hope, Sir, that you will not weary in well-doing, but will now challenge also the definition of economic progress as "the orderly assimilation of innovation into the general standard of life" for placing the cart before the horse? Economic progress is the raising of the general standard of life in conformity with scientific achievement.

The key to the distribution of the fruits of scientific innovation lies in financial technique, which is simply a matter of arithmetic. Purchasing power is a claim on the product of industry, and the possession of purchasing power confers on the individual that which Sir Josiah Stamp rightly states as the "central feature of economic progress, namely, individual choice of the consumer in the direction of his demands." And that, Sir, is not a question of making gramophones before you can purchase boots. On the contrary, it is simply a matter of arithmetic.

London, September 28th. W. L. Bardsley.

Sir,—In your leading article of September 22nd, you sagely remark on an address to the British Association having the sinister title "Must Science Ruin Economic Progress," that it calls for greater application than even the most attentive can give in the lecture hall. This is the more necessary since the definition with which the discourse opens actually begs the whole question at issue.

"Economic progress," it runs, "is the orderly assimilation of innovation into the general standard of life." That definition, if accepted, is the very charter of those who suggest that technical advance is too rapid, that it must be controlled, retarded, and even discouraged or punished.

Before submitting a definition which is more in accordance with evolution, with human aspiration, and with the very nature of things, please let me call attention to the euphemism for control in the word "orderly," a euphemism which is repeated in the conclusion of the discourse in the phrase "large infusions of social *direction*." Notice also the correspondingly derogatory use of the word "innovation," which conveys the idea "new-fangled" instead of what has been called "the progress of the industrial arts."

A better definition of economic progress may be obtained by reversing the above to read, "the advance in the general standard of life resulting from 'innovation'"; but even that suffers from the same lack of precision as the original, and, as you say in your second leader, "Science" (which need not exclude economic science), "consisting as it does of nothing but precision of observation followed by precision of thought, demands for the communication of its knowledge precision of expression. If it is to survive, let alone progress, it dare not employ loosely defined terms."

Economics are concerned with the provision of mankind's material needs, which are goods and services, and the goal of economic progress is perfection in that provision. I, therefore, submit as a suitable definition with which to begin the study you recommend, the following:—"Economic progress consists of increased capacity to produce and deliver goods and services as required, with the same or less expenditure of energy."

London, W.C.1, September 29th. W. T. Symons.

THE GROWTH OF SCIENTIFIC JARGON.

Sir,—The progress of science and engineering, as a whole, depends on the interchange of ideas. As you point out, this interchange between technicians necessitates the use of "specially selected or restricted meanings" to words. What I urged at Leicester was that it is time to call a halt in the game of applying special new or restricted meanings to words. For example, as a student of geology, I still do not know what a geological bifed is. Of course, I have naturally met the term in other branches of science.

The suggested use of only 850 words in basic is for the communication of ordinary ideas; an additional hundred words are required for general science. There is no question of trying to express science papers in 950 words—the word list is not intended to include thousands of proper names which are necessary. On the other hand, supporters of basic English are alarmed at the very "magnitude and free growth of the language" which you praise. We do urge most strongly that it "is" time to introduce a definitely restrictive agreement on the enormous growth of different terms and different names for the same things in different languages. A start on these lines has been made by organic chemists. In Germany a great deal of attention has been applied to the standardisation of electrical engineering terms, and in the U.S.A. a big movement is now on foot to review scientific and technological terms used in a variety of industries.

I can see no logical reason for, and no scientific gain whatever from, a multiplication of different names in engineering and science for the same things in different languages. One might as well suggest that 480 different names should be invented for the kilogramme so that every nation and native tribe could indulge in freedom to introduce new names and assist in the unrestricted development of its language. B. W. Holman.

London, September 28th.

RAILWAY SPEED.

Sir,—Your paragraph in The Engineer this week on the "remarkable speed records" established by the L.M.S. Company between Euston and Coventry on September 19th, omits to mention the fact that the timing of trains between London and Birmingham has not been improved by so much as a single minute for over thirty-one years. Indeed, the present timing, though nominally the same, is actually rather slower than it was when my old friend, the late Charles Rous Marten, wrote an account of a Birmingham to London journey in The Engineer for August 8th, 1902.

Between other great business centres, such as Paris-Bordeaux, Berlin-Hamburg, or New York-Buffalo, railway service becomes steadily better and better; here, in Britain, what was good enough for our fathers is still considered good enough for us.

Anyone who travels in foreign countries to-day must be struck by the general rise in the standard of railway performance; the French would take an hour off the time allowed for the non-stop "Flying Scotsman" between London and Edinburgh, and our possession of one "Cheltenham Flyer"—a light train in a service of minor importance which runs at high speed for part of its journey—is poor compensation for the existence of many services, which, according to modern ideas, are quite second-rate. W. B. Thompson.

London, S.W.1, October 2nd.

The Victoria, Southern Railway, Buffer Stop Collision.

At about 8.47 on the morning of April 25th last, the 7.40 a.m. electrically operated train from Brighton collided with the spring buffer stops at the end of No. 14 platform, Victoria. There were no serious personal injuries, whilst only trifling damage was done to the rolling stock, and the buffer stops were not displaced. The rails near the buffer stops were slightly greasy.

The train consisted of twelve bogie vehicles in two six-coach sets. Its length was about 226 yards and its unladen weight about 532 tons. It was fitted with the Westinghouse brake, working blocks on all wheels. Screw couplings and side buffers, the latter of a heavy shock-absorbing type, were in use throughout the train. The draw and buffing gear was undamaged by the collision.

An unusual feature of the accident was that although the train appears to have entered the station at normal speed, and the impact between the leading motor coach and the buffer stops was not severe, there was a violent rebound of the three coaches at the rear of the train, in which many of the passengers who were injured were travelling; the brakes of these three coaches were found to be off immediately after the accident.

In order to ascertain the time needed for a brake application to become effective at the rear of a twelve-coach train, the company arranged to make some tests at the Selhurst depôt.

In the fourth of these tests attempts were made to reproduce the conditions of the accident; that is to say, to apply the brakes on the first nine vehicles and not on the last three, by manipulating the brake valve in the manner described by the motorman. After applications with 10 lb. to 12 lb. reduction in train pipe pressure lasting for about 1½ minutes, corresponding to the time taken to run from Grosvenor Bridge to the entrance to the station, the brake valve was placed in the release position for ten to fifteen seconds. During the ensuing thirty to forty seconds several slight applications were made, without moving the handle back to the lap position, with resultant total reductions of from 25 lb. to 30 lb. in the train pipe pressure. In all cases the brakes were found to be applied throughout the train at the conclusion of the tests.

A further test was then made to reproduce as far as possible the manner of handling the brake valve described by the motorman at the company's investigation of the accident. The original application and release were made as in the fourth series of tests, and the brake was then applied again, with 10 lb. reduction of train pipe pressure, for twenty seconds, representing the run from the entrance to the station up to Victoria North signal-box. The brake valve handle was then moved to release for twenty seconds, after which two short applications, each of about a second, were made. It was found after this that the brake was applied on the first six vehicles of the train, but not on the last six; another short application applied the brakes on the seventh and eighth coaches, and a further one, rather more lengthy, applied it on the remaining four vehicles of the train. It was also found that in releasing the brake after this test the triple valves on the twelfth vehicle reversed six seconds after the brake valve was placed in the release position; the blocks on this coach did not leave the wheels until a further nine seconds had elapsed, or fifteen seconds in all after the brake valve was operated.

In the conclusion to his report, Colonel Woodhouse says that it is clear from the evidence that the speed at which the train entered the station and approached the buffer stops was not excessive, though, in this connection, the motorman's estimate that his speed was only 5 miles an hour at the platform ramp (420 yards from the buffer stops) is obviously faulty; the platform is nearly a quarter of a mile long, and at such a speed a train would take three minutes to reach its inner end.

He is of opinion that the accident was due to errors of judgment on the part of the motorman, not only in delaying the final applications until the train was too close to the buffer stops, but also in the manner in which these applications were made, and that responsibility for it rests with him alone.

The Report concludes with the following summary and recommendations:—(1) The collision with the buffer stops was due to errors of judgment in handling the brake on the part of motorman Coughtrey, resulting in it being temporarily inoperative on the three rear vehicles of the train immediately before the accident. This gave rise to a violent rebound of the three vehicles in question.

(2) The response of the ordinary Westinghouse brake equipment to the motorman's actions, while quicker than that of the vacuum brake, is far from being instantaneous. Consequently, more dexterous operation of the brake is needed on long trains than on short ones; liberties which can be taken with it on the latter, without untoward results, may easily give rise to unevenness of braking on the former.

(3) No reasonable objection can be raised to the company's practice of transferring motormen from heavy expresses to short suburban trains and *vice versa* during the course of a day's work. But as this may lead to injudicious handling of the brake on the longer trains, through momentary forgetfulness on the motorman's part, the need for deliberation in the manipulation of the brake valve on all occasions, on short as well as on long trains, should be impressed upon motormen.

(4) Two improved forms of Westinghouse brake equipment have been developed, namely, the high-speed air brake and the electro-pneumatic brake. Both of these give to the motorman fuller control of brake action than he has with the ordinary Westinghouse equipment; in addition, the second possesses features rendering it specially suitable for use on multiple unit electric stock, of which a very important one is that the response of the brake to the motorman's actions is not affected by the length of the train. This simplifies the task of a motorman who has to change round frequently between trains differing in composition and length.

(5) While it is true that the operating conditions of an express service, with infrequent stops, differ from those on the London Underground, on which the electro-pneumatic brake is understood to be giving excellent results, it appears, nevertheless, that in any type of service the added measure of control of the brakes afforded by these improved patterns of equipment must be valuable. I suggest, therefore, that the company be asked to consider the experimental use of, at any rate, one of these two forms of improved brake equipment—preferably the electro-pneumatic—in order that it may be ascertained if the advantages described are realised in practice, and justify the expense involved, having regard to the various operating conditions of their electrified services.

Experiment of this nature on surface lines would appear to be distinctly advantageous at the present time, in view of the possible extension of electrification.

The Institute of Marine Engineers.—Since the Royal Charter was granted to the Institute in March last, an important alteration has been made in the regulations governing the admission of students. A detailed syllabus of the student examination has been issued, with particulars of exemptions open to candidates possessing certain educational qualifications. The next examination will be held in May, 1934, at various centres, according to the candidates' places of residence. Full particulars may be obtained on application to the secretary, the Institute of Marine Engineers, The Minories, London, E.C.3.

Railway and Road Matters.

The oil-electric "railbus," designed and built by Armstrong, Whitworth and Co., Ltd., is now in regular service between Newcastle and North Wylawn.

The report by Lieut.-Colonel Woodhouse on the buffer stop collision of April 25th at Victoria, Southern Railway, was issued on September 30th and is reviewed on another page.

All four grouped companies had not only, as was to be expected, increases in passenger traffic for the thirty-eighth week, but in goods traffic also. The several increases in the latter were:—Great Western, £20,000; L.M.S., £22,000; L.N.E., £38,000; and Southern, £3000. The Southern has now an advance of £51,000 in its total receipts for this year as compared with the corresponding period of 1932.

A recent letter in *The Times* on the subject of the electrification of railways, points out that were all the lines running into New-street Station, Birmingham, worked by electricity, that station could be covered in and thus provide space which could be used for the great benefit of the city. We draw attention to this suggestion because of the large sums of money that now come in that way to the Grand Central Station in New York.

On Saturday evening last, September 30th, as a passenger train from Glasgow to Ardrossan was running between Beith and Glengarnock, one of the carriages was struck by an obstruction from a passing goods train and a passenger killed. It is said that it was an iron bar, which was part of the structure of one of the wagons, that had become detached. It might, we suggest, have been a load that had shifted in transit; in either event the occurrence was unusual.

When Mr. W. K. Wallace came from the position of engineer and locomotive engineer for the L.M.S. Northern Counties Committee to Euston in 1930 to be chief storekeeper, and, later, chief civil engineer, he was succeeded at Belfast by Mr. H. P. Stewart, who has now retired and his duties have been taken over by two of his assistants; Mr. R. L. McIlmoyle, assistant engineer, becomes the civil engineer, and Mr. M. Patrick, the running superintendent, is made the locomotive engineer.

But for the unfortunate death, on July 6th, of Mr. W. A. Traill, its founder, the Giant's Causeway Railway would have celebrated its jubilee last week. Actually the line was inspected by General Hutchinson, on behalf of the Board of Trade, on January 12th, 1883, and opened on the 18th idem. As the proposed electrical equipment was not ready the line was worked by a steam tramway engine. On September 28th following the work was complete and was then formally opened by Earl Spencer, the Lord Lieutenant.

In any consideration of the Ministry of Transport railway statistics for June it must be remembered that it includes Whitsuntide, whilst that holiday period was in May last year. The number of passenger journeys was 6·7 per cent. more in June, 1933, than in 1932, and the receipts were up by 12·6 per cent. For the four weeks ended July 15th the tonnage of freight increased by 4·6 per cent. over the corresponding period of 1932, and the receipts by 0·6 per cent. There was a rise of 1·2 per cent. in the freight train miles and the average train load increased from 113 tons to 116¾ tons and the net ton-miles per engine hour from 427½ to 446.

Spray-cleaning for locomotives is now in force at a number of depôts in the southern area of the London and North-Eastern Railway. According to that company's magazine for September, the plant consists of an electrically driven automatic-controlled three-throw hydraulic pump, which forces a mixture of hot water and a degreasing compound, such as soda ash, through suitably arranged pipes to the near vicinity of the engines to be cleaned at a pressure of 375 lb. per square inch. Flexible pipes are coupled to the fixed supply line, and the cleaning mixture is ejected from a specially designed gun in a solid jet of fluid which may be directed with considerable force to any part of an engine which has to be cleaned.

The announcement that the London, Midland and Scottish Railway is about to strengthen the bridges between Mangotsfield and Bath on the former Midland Railway, raises the question why that is being done. The line, which was opened on August 4th, 1869, carries no heavy traffic except the Bournemouth expresses to and from the North. The explanation is probably to be found in the fact that the L.M.S. is responsible for the locomotive power for the jointly owned Somerset and Dorset Railway—the Southern Railway takes the civil engineering—and to deal with the steep gradients on that line has some heavy locomotives stationed at Bath. The strengthening of the bridges in question will permit a wider use of those big engines.

There was a sequel, at the County Police Court, Penrith, on Wednesday, September 27th, to the fatal collision of July 10th at Little Salkeld, which explains why the coroner's inquest at Carlisle was again adjourned on September 12th. The sequel was that the signalman was charged with manslaughter and was subsequently committed for trial at Cumberland Assizes. The signal-box at Little Salkeld is opened only when any shunting movements have to be made, and about 1 p.m. on the day in question a down freight train arrived which had a wagon to place in the siding on the up side. Before the points could be opened for the shunt to be made the up distant and the up home, which stood at "clear" whilst the box was closed, had to be put to their normal position, but before that was done the signalman should turn the switching-out instrument, which would tell him if any trains were in the Lazonby-Langwathby section, in which Little Salkeld is an intermediate box. It is charged against the signalman that he did not turn the switch, but, instead, put the signals "on" and opened the points. An express from Carlisle to St. Pancras was, however, in the section and it had passed the distant, 750 yards away, before it was changed, and the express consequently caught the engine that was shunting and so injured the driver that he died in Cumberland Infirmary the following day.

Notes and Memoranda.

The number of telephone stations connected to the Post Office system at July 31st was 2,159,140, an increase of 3551 over the total at the end of June.

The House Committee of the Victoria Parliament has been asked to consider the improvement of the acoustic properties of the Legislative Assembly Chamber by the installation of a system of amplifiers operating loudspeakers.

The manufacture of ethylene dibromide for use as a constituent of anti-knock motor fuels probably represents the most important industrial outlet for bromine to-day. The content of bromine in sea water, about 0·007 per cent., seems, says the *Chemical Trade Journal*, uneconomically small, but the magnitude of the total quantities available will be appreciated by realising that 1 cubic mile of sea water contains 600 million pounds of bromine.

The study of wood shrinkage has been continued by the Forest Products Research Board, and various further aspects of the subject investigated. The contention that old timber is more stable than newly seasoned timber is being studied. Sample pieces of old timber have been obtained from old buildings and matched samples of new timber have been prepared. The matched pairs are being subjected to changing atmospheric conditions, and any dimensional changes noted. At the moment the indication appears to be that there are only slight, if any, differences in the amount of movement of old and new wood.

A very unusual form of boiler explosion is described as follows in the latest report on factory accidents issued by the Home Office. A boiler used for supplying steam to a gas generator had been emptied, for renewal of the fusible plug, and the stop valve on the steam pipe to the generator closed. After removal of the manhole cover, a worker approached the manhole with a lighted candle. An explosion occurred and the worker was burnt. It was subsequently found that the stop valve was faulty, and the removal of the water presumably caused some residual gas from the generator to be drawn into the boiler shell. This accident shows that where leakage of gas is liable to occur it is not safe to rely solely on a closed valve; in all such cases a blank flange should be inserted in the pipe line to prevent the danger of an air-gas mixture being formed. In addition, naked lights should obviously not be used in places where inflammable gas may be present.

It appears from a note in the *Electrician* that unless action is taken at once the influx of Japanese lamps will be supplemented by a serious invasion of the British market by Russian bulbs. The Soviet Government is said to be preparing to ship millions of electric lamps to this country at a wholesale price of 2½d. each, to be sold retail at 4½d. to 6d. An *ad valorem* duty is quite useless to deal with a menace of this kind. The Import Duties Advisory Committee was asked by the British lamp manufacturers a year ago to substitute a specific duty for the 10 per cent. *ad valorem* duty now in force, but nothing has yet been done, and a British industry which gives employment to large numbers of workers and represents an investment of several millions sterling is now faced with the prospect of competition, not only from low wage countries, but, our contemporary concludes, from a State which trades at prices that have no relation to the actual cost of production of goods.

An oil engine of the sleeve valve type failed after a few weeks' service and was rather badly wrecked. Subsequent investigation suggested that the cause of the trouble was the "gumming up" of the valve sleeve. Commenting on the incident, *Vulcan* suggests that the formation of gum on the sleeve was apparently caused by the engine having been consistently run with the cooling water which supplied the jackets at too low a temperature, the water in question being on a run-through system direct from the pumping station mains. Arrangements have therefore been made for heating the circulating water in future, in order to avoid the possibility of a recurrence of breakdown and damage from this cause. It might be added that it is not, as some oil engine owners are inclined to think, good policy to work an internal combustion engine with the jacket water at too low a temperature, as not only has it been shown that this results in low fuel efficiency, but, at the same time, it increases the wear on the cylinder liners.

An accident, resulting in the death of one workman and injury to several others, occurred during the extrusion of small rods of an alloy containing 55 per cent. zinc and 45 per cent. lead. Following the receipt of a (foreign) trial order for rods of this composition, an ingot was prepared by pouring the requisite mixture into an open cast iron mould standing on end. The ingot was allowed to cool thoroughly and a discard of about 25 per cent. was removed by cold sawing. The billet, after being reheated, was placed in an extruding machine with the sawn face to the die and extrusion commenced. About 75ft. of metal were successfully extruded through each of the holes in the die plate, when fragments of metal were suddenly projected forwards at a high velocity. Two men guiding the extruded rods down the delivery trough both received a large number of wounds and two other workers were less seriously injured. Subsequent analysis showed that both the discard and the extruded rod consisted of zinc containing about 2 per cent. of lead and that the projected fragments and the part of the billet which remained in the machine (with the exception of a thin layer of zinc near the die plate) consisted of lead containing 1 to 2 per cent. of zinc, which indicates that the mixture of metals, on cooling in the mould, separated into lead and zinc. The billet had been placed with the zinc end towards the dies and zinc rod was first extruded quite evenly; when the thickness of the zinc layer had been reduced to about ¼in. the lead was forced through it with explosive violence and projected at high velocity from the machine in the form of irregular nodules. This accident, states the Home Office report on factory accidents, illustrates the fact, well known to metallurgists, that lead and zinc will not alloy at ordinary temperatures except to the extent of about 2 per cent. of either metal with 98 per cent. of the other.

Miscellanea.

Two electric power plants, each with an output of 130 kilowatts, are being erected near Balaklava.

The Portland cement plant at Saichuen, in the western suburbs of Canton, is being extended to double its present capacity of 1300 barrels a day.

Owing to the death of its President, Mr. T. W. Ellis, Mr. C. Strachey Hawdon, A.M. Inst. C.E., M.I. Mech. E., A.C.G.I., has been elected to fill the presidential chair of the Institution of Engineering Inspection for the remainder of the current session.

It is expected that the output of one of the blast-furnaces of Dorman, Long and Co., at the South Banks Works, which has been remodelled and its hearth diameter increased from 12ft. to 16ft., will now be twice the original amount of 200 tons a day.

An important phase in the development of Sierra Leone, one of the oldest British West African possessions, is marked with the arrival at Glasgow of a shipment of 8000 tons of iron ore from the Colony. It is now believed that Sierra Leone will be able to supply Britain with a large proportion of its foreign iron ore requirements.

Two new electric winding machines are to be installed by the Union Corporation, Ltd., of Johannesburg. They are to be of the Ward-Leonard type, with mechanical parts by Fullerton, Hodgart and Barclay. The maximum load is to be 6000 horse-power, and they will wind from a depth of 4400ft. The contract price is over £50,000.

The Dominion Bureau of Statistics at Ottawa reports that selenium production in Canada during the first six months of 1933 amounted to 8600 lb., valued at 17,200 dollars. This metal is obtained as a by-product in copper refining, and was produced for the first time in Canada early in 1931 at the plant of the Ontario Refining Company, Ltd., Copper Cliff, Ontario.

At Marioupol, close to the shores of the Sea of Azov, construction work on the great Azovstal steel plant is proceeding at a rapid pace. The first Azovstal blast-furnace has just been started up. It is built on lines identical with those of the furnaces at Magnitogorsk, but it is slightly smaller, having a capacity of only 930 cubic metres. The works are being connected with the sea of Azov by means of a ship canal.

Speaking at the annual dinner of the British Commercial Gas Association, Dr. Burgin, Parliamentary Secretary to the Board of Trade, said that the most important result of legislation to follow the Departmental Committee's report would be to enable the industry to grant to consumers who would take bulk supplies at off-load periods, better-priced terms than could be given to consumers who were unable to offer such advantages to the industry.

The newly built Ryon hydro-electric station in Russia has been set to work. The station, which is on the river Ryon near Kutais, has a capacity of 48,000 kilowatts, and is the largest hydro station in Transcaucasus. It will supply energy to the electrified section Zestafani-Stalinici of the Suram Railway, the manganese plant and various factories in Kutais, as well as to collective farms in Georgia. The station is equipped entirely with Soviet-made machinery.

The 3,000,000-dollar bridge spanning the St. Lawrence River between Caughnawaga and Ville La Salle, which is being erected by the Lake St. Louis Bridge Corporation, will, says *Canada*, in all probability, be completed approximately a year ahead of time. Plans called for completion of the structure by May 1st, 1935, but it is now probable that the work will be finished by July 1st next, according to the Minister, who added, "At the present time the contractors are both ahead of time and under original estimates."

Two new three-phase Heroult furnaces have been completed at the wire works buildings of the Union Steel Corporation at Vereeniging. These furnaces have, says the *South African Mining and Engineering Journal*, been installed primarily for the production of hollow drill steel, but they will also produce tool and alloy steels of the types required by local industry. Between them these furnaces will have an annual capacity of close on 5000 tons of liquid steel, giving a marketable yield in the region of 3000 tons.

Plans are already well advanced for the erection of a new synthetic rubber factory, for which a site has been laid out a few kilometres from Erivan, in Russia. Work has been started on the building of accommodation for the labour force and technical staff. The new factory will be conveniently located with respect to carbide and chromide plants, the sources of raw material required in the manufacture of synthetic rubber, and electrical energy will be transmitted from the new Kanakir electric power station, over a distance of some 10 kiloms.

An interesting ceremony was performed on October 2nd, at the Forth Paper Mill of J. A. Weir, Ltd., Kilbagie, when Mrs. S. S. Lamert, wife of the chairman of the company, started up the new Yarrow boiler plant, and Mr. Lamert opened the steam valve to transfer the works load to the new plant. It is anticipated that the consumption of fuel will be reduced by approximately 35 per cent. from that required for the old plant which is being replaced, and that the lower grade of fuel, so plentiful at Scottish collieries, will be utilised, and freedom from smoke and grit trouble will be secured.

The outstanding feature of the Janjula hydro-electric power station which utilises the water of one of the principal tributaries of the upper Guadalquivir, in Southern Spain, is, says the *Electrical Review*, that it is built entirely in the dam of the power development. This dam is a solid gravity type dam of concrete, 306ft. high and having a length of 720ft. at the crest. The machine-room as well as the rooms containing the H.P. switchgear, are in the form of vaults at the base of the dam, the outer walls being up to 10ft. thick. The power station is equipped with three vertical generating sets. Two of these have a capacity of 7500 kVA, while the third develops 3750 kVA at 10,000 volts, 50 cycles, three-phase.

RAILWAY AXLE PLANT FOR RUSSIA

CRAVEN BROTHERS (MANCHESTER) LTD., REDDISH, STOCKPORT, ENGINEERS

(*For description see page 330.*)

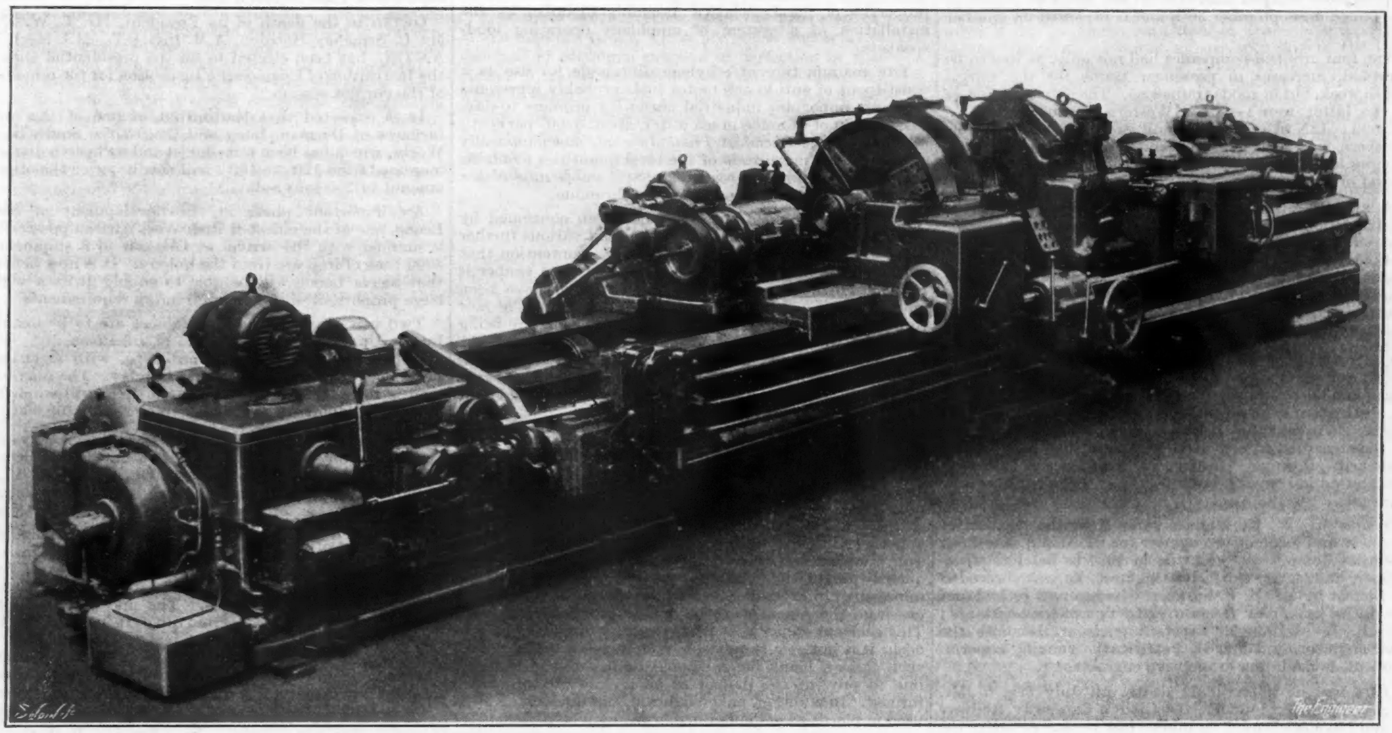

The Engineer

FIG. 6—AXLE PARTING, ENDING, CENTERING AND SHOULDERING MACHINE

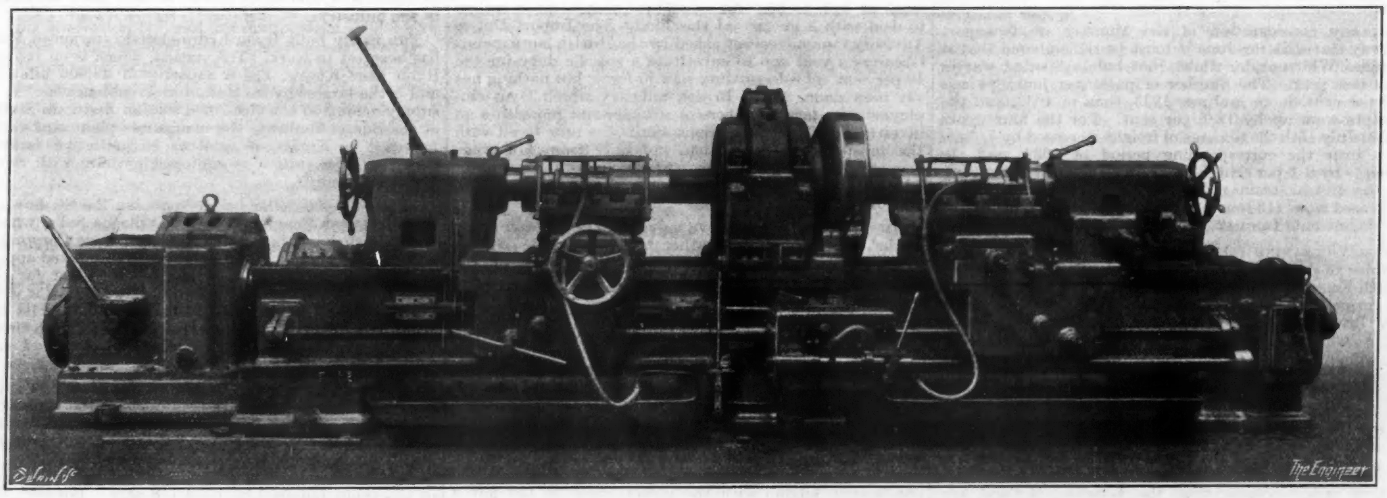

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FIG. 7—AXLE ROUGHING LATHE WITH 60 H.P. MOTOR

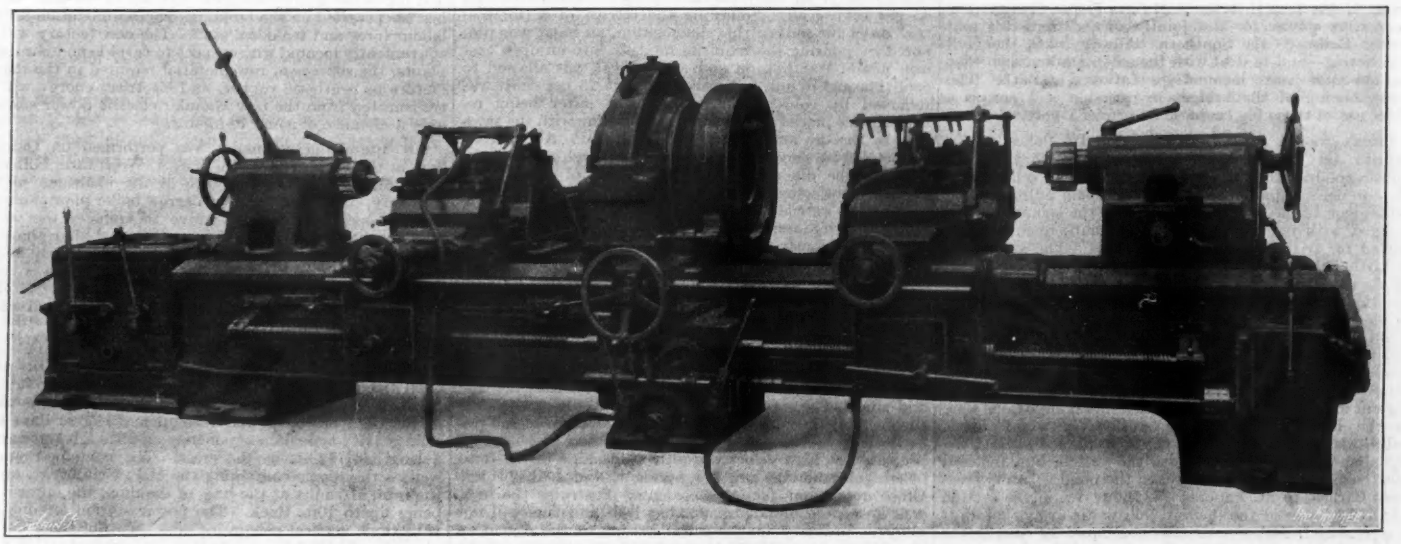
The Engineer

FIG. 8—AXLE FINISHING LATHE WITH 20 H.P. MOTOR

The Engineer

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PATENTS & GOVERNMENT DEPARTMENTS.

UNDER the Order in Council of July, 1915, amended in 1928, by which it was established, the Department of Scientific and Industrial Research is permitted to take out patents for inventions and discoveries made by its servants and research workers. In 1922, an Inter-Departmental Committee presided over by Mr. Kenneth Lee considered the question and reported upon the methods to be followed in connection with patents made by "workers aided or maintained from public funds." That Committee did not report on the propriety or otherwise of patents being held by public servants or Departments. But even in the earliest days of the D.S.I.R. it was foreseen by astute observers that this privilege would, sooner or later, lead to trouble with private inventors. Recent events, which need not be particularised, have brought that matter to a head. The leaders of the present movement are chemists and chemical engineers, but the question is of moment to all who are engaged in any of the activities in which the D.S.I.R. interests itself. It is an extremely difficult one, in which the *pros* and *cons* are so nicely balanced that a decision one way or the other—in favour of or in opposition to the holding of patents by a State organisation—cannot readily be reached. That injustice, or apparent injustice, may sometimes be done to the individual is not in doubt, but apart from the fact that the public weal must come before individual benefit, cases may arise, and have arisen, in which the patents of the D.S.I.R. have restrained foreign competition and by so doing have aided the British manufacturer.

In view of the certainty that before long the matter may receive public attention, we think it may be of assistance to our readers if, without swinging to right or left, we devote a few words to a presentation of the main aspects of the problem. In the first place, it is desirable to recall the purposes for which the Department of Scientific and Industrial Research was established. According to the terms of the Order in Council of 1915 it is "to direct, subject to such conditions as the Treasury may from time to time prescribe, the application of any sums of money provided by Parliament for the organisation and development of Scientific and Industrial Research." At first its energies were directed principally to encouraging, and to helping financially, Research Associations established by industries. But it soon found a necessity to carry on researches of its own in the national interest, and at the present time, in addition to the National Physical Laboratory, numerous researches are directed by it, amongst which may be mentioned Building Research, Chemical Research, Food Investigation, Forest Products Research, Fuel Research, Radio Research, and Water Pollution Research, and it has several research stations and laboratories. From its very nature much of the work carried out in these laboratories has industrial value and importance, and many of the results are patentable. There were three courses open to the Department with regard to the latter. It could, like the national research organisations of other countries, protect them by patents taken out in the ordinary manner; it could throw them open to the world; or it could reveal them to certain selected individuals or firms for the purpose of industrial development. At first sight it would appear that the right course for a public body, supported by public funds, is to publish openly its discoveries and inventions. We may recall a story which shows what may happen when that is done. Many years ago, Laval, the inventor of the centrifugal separator, designed a hand-worked cream separator for use in the household. In the interest, he believed, of the world at large he threw the design open to all and sundry. Anyone who desired could make it. But the result was the very opposite of that intended. Instead of a plentiful supply of these little separators at competitive prices, none were made because no one could secure a monopoly for their manufacture. This familiar story shows just what might occur if the D.S.I.R. made it the standard practice to publish its inventions to the world. To guard against that mishap it decided to keep control of its inventions by patenting them and by licensing the use of them under royalties in the usual way. A further advantage is gained by this course in that foreign competition can be checked or controlled. Against this argument in support of departmental patents we must set down a possible injustice. It may happen that the Department is working on a problem which has also attracted the attention of private individuals or firms, and that the same solution is reached by the Department, with its excellent resources and public moneys, before the individual or firm. If then the Department covers the invention by a patent the private worker is robbed of the fruits of his labour. Manifestly the condition set up is undesirable. For, on the one hand, the private individual will be discouraged from making inventions, foreseeing that it is more economical to leave that work to the Department; or, on the other, he may be tempted to take out a great number of "keep off the grass" patents in order to circumvent the Department. There are already too many patents of this kind, and anything which tends to encourage their multiplication is to be deprecated. But in this connection it is very important to remember that whilst the D.S.I.R. has no right to ask private manufacturers what they are doing, the research programme of the Department is open to all manufacturers. Furthermore, if any firm engaged in a research has reason to believe that the D.S.I.R. is interested in the same research, it will be shown what the Department is doing, and if the Department is satisfied that the firm is covering the ground it may either co-operate with it or delete the item from its own programme. The third alternative open to the Department is to place its inventions in the hands of a selected firm or group of firms with permission to protect and use them, either for or without a "financial consideration." Whilst the arguments which may be advanced against that course leap to the eye, it has merits which cannot be overlooked, and which in certain cases would seem to outweigh the objections. In any case it cannot be hastily dismissed on the ground that it may be a form of favouritism. In the cause of national economy it may be the right and proper thing for a national body to go direct to one or two firms which, by their association, are known to have the means and the ability to make the best of an invention.

From this brief survey of the position it will be seen how difficult the problem is. One solution is to close all the Department's research laboratories, and we believe there are some who favour that course. But if the laboratories directed by the Department were closed down, what would be done with the laboratories, like that, for example, of the Cast Iron Research Association, which also may take out patents and are in part supported by the Department; and what with the private research workers in colleges who may secure patents on inventions resulting from labours for which the Department has, in part, paid? Logically, the rule would have to be enforced that no laboratory and no individual receiving payment of any kind from the D.S.I.R. may cover any resulting invention by a patent. Such a rule is unthinkable, for it would not only hit the State laboratories and private workers, but would weaken the activities of the Research Associations, for the encouragement of which the Department was established. The only *complete* solution is the demolition of the whole structure of the D.S.I.R., which even its severest critics would scarcely desire. We trust that some *via media* between the best interests of the nation and of the individual citizen may result from deliberations which are now taking place.

Autumn Meetings.

Two important institutions, the Iron and Steel Institute and the Institute of Metals, have just held their autumn meetings at Sheffield and Birmingham respectively. Both may well be described as successful and even brilliant. There can be no doubt that the improved industrial atmosphere at Sheffield contributed much to the success of the Iron and Steel meeting, both in regard to the lavish hospitality which was extended to the visitors and to the spirits and energy of those taking part. At Birmingham, also, where the Institute of Metals celebrated its twenty-fifth anniversary, there were signs of renewed energy and activity in many directions.

While, therefore, we can congratulate both Institutions upon their meetings, we feel that there is room for some comment. There is, on these occasions, always some divergence of opinion as to the nature of the papers which should be read and discussed. There are those, and, to a large extent, we sympathise with them, who consider that papers of direct industrial interest, if possible specifically relating to the industries of the district where the meeting is held, should constitute a prominent feature of the programme. So far as the Iron and Steel Institute is concerned, this type of paper always forms a large proportion of its proceedings, and the meeting at Sheffield was no exception. Many of these papers are of very great interests, and are prepared not only with skill and ability, but with a degree of frankness on the part of the authors and the firms they represent which is most commendable. On the other hand, it is a criticism which could have been justly levelled at the Iron and Steel Institute on previous occasions that the more scientific aspect of iron and steel metallurgy does not receive adequate attention at the meetings themselves. At Sheffield we are glad to say that this want of balance was not so apparent. Some scientific papers, among which we are glad to include certain sections of the Fifth Report of the Committee on the Heterogeneity of Steel Ingots, received very satisfactory discussion of a character which should be helpful to the further progress of the work. At the Institute of Metals, on the other hand, there was a very distinct lack of balance. Mr. Barclay's Autumn Lecture, which we have reproduced in abstract, did, of course, deal in a most interesting manner with purely industrial matters, and one or two of the other papers related to alloys which appear to have a promising commercial future. All the remaining papers, however, both those read and discussed, and those merely formally presented, were definitely of the "research" type. While we recognise the value of papers of this kind and the good work which the Institute of Metals has done, and is doing, in affording facilities for their publication and discussion, we still feel that a larger number of papers of a more directly industrial type should be contributed either by manufacturers of non-ferrous metals, or by the engineer-users of these materials. They would certainly add very much to the value not only of the meetings themselves, but of the published "Proceedings" of the Institute. We believe that the Council of the Institute of Metals is most anxious to secure papers of this kind, and, therefore, suggest that it is the duty of engineers and manufacturers to provide the necessary material. We cannot believe that subject matter for such papers does not exist in ample measure throughout the non-ferrous industries, nor that the men engaged in these industries are incapable of putting their facts and experiences into a form which would be acceptable to their colleagues. Possibly, however, there may still be a certain measure of the old attitude of secretiveness in these industries, and this may perhaps be holding back information and views in reality suitable for publication.

We cannot enter here into the large subject of the desirability for publication and the free interchange of knowledge and information, not only of a scientific, but of a technical and practical nature. We would only remind those who still hesitate on this point that experience has shown that firms and individuals who are most ready to communicate the results of their own experience have always been found to profit by the interchange which such publication brings about. While we realise that there are occasions when temporary non-publication is desirable, or even necessary, we feel satisfied that there is a great deal which could and should be described and discussed, and that, if it were, general benefit to all concerned would result. The Institute of Metals, in particular, provides a field where both the manufacturers and users of metals can profitably exchange their views. Possibly some of them are a little shy of an atmosphere which is perhaps somewhat scientific, but we suggest that such shyness is unnecessary and unwise. We feel sure that no one would be better pleased to see industrial papers presented and discussed than the scientific metallurgists themselves. The fructification of their work must largely lie in the development of industry, and new fields for application will often be opened up by a free discussion of industrial rather than purely scientific problems.

Waste in Manufacture.*

By C. R. F. ENGELBACH.

THE structure of all prime manufacturing costs is built up solely on the price of labour and charges—the labour expended in winning the raw materials from land, air and sea, and transporting them to different stations, whereby, again by labour, they are converted into finished articles.

It is calculated that in any finished mechanical appliance about 84 per cent. of the cost is productive labour, the remainder being represented by fixed charges and whatever profits may accrue during the various processes through which it passes from raw materials to the finished article.

Nature provides all basic materials free of cost, and as she is lavish in her gifts, it is perhaps for this reason we are so prodigal in our use of them. These free gifts are supplied for the use of mankind in vast quantities, but, owing to our imperfect knowledge, we have to pay in terms of labour very heavily for adapting them to our purpose.

During the last twenty years, however, the labour employed in the manufacturing of motor cars from semi-raw materials has been steadily decreasing. We are only a finishing industry, and therefore our cost structure includes the purchase of semi-finished material to which we add our own productive labour; but the ratio of this labour cost to the "material cost" has in the last few years, in consequence of improved methods and organisation, decreased enormously, and the material cost now forms a very much larger proportion of the total than formerly.

Our efforts have been concentrated on reducing operation times by minutes and seconds. New plant, new machines, new devices to save time in machining or handling; new methods, new processes and new ideas on organisation have flowed unchecked from the brain of the engineer.

Thousands of pounds have been spent on installing new plant and labour-saving devices, but I venture to say that insufficient attention has been paid to the elimination or reduction of the waste—the appalling waste—that occurs in the materials we use in the production of a car.

In brief, in twelve months, the Austin Motor Company purchased 68,777 tons of materials, out of which 18,200 tons were *entirely finished* and required no labour before assembling into a car. In order to finish these goods and to deliver them in completed cars we used 14,112 tons of commodities which might be termed "Consumable Stores," and the fuel used for power and light supplied by ourselves and from Corporation sources, heating and various processes, came to no less than 63,157 tons. Adding these together, we arrive at the following:—

Productive materials	68,777
Consumable stores	14,112
Coal and fuel	63,157
Total	146,046 tons

The total weight of the goods sold in motor cars and spare parts was 33,762 tons, so that by a process of simple arithmetic it will be seen that the loss in tonnage was 112,284. In other words, we delivered to our customers 26 per cent. of the total materials received and 74 per cent. was consumed or wasted in various processes.

The Foundry.—Even before the foundry starts its legitimate work an enormous tonnage of materials has been used to provide the pig iron from which our castings are made. In order to produce 170 tons of finished castings, 1000 tons of iron ore, 600 tons of coal, and 200 tons of limestone, a total of 1800 tons, have been used to produce this relatively small tonnage of castings, and although we who run foundries can only control the process from the receipt of pig iron as a semi-raw product, even then we use 276 tons of this commodity for our 170 tons of castings, and are responsible, therefore, for a loss of over 60 per cent., irrespective of the coke and other ingredients we use in their manufacture.

I feel bold enough to state that the engineer has not yet come into his own in the foundry, and more often than not there is an air of mystery and superstitition in the method of making castings, reminiscent of the days when the leg of a frog or a bat's wing were added to the mix to ensure a perfect result.

The Stamp Shop.—Stampings produced by forging hammers, drop stamps, steam hammers, hydraulic presses, or upsetting machines, form the basis of a more modern process of manufacture than the foundry.

The loss of accumulated labour during the process of converting iron ore into the finished stamping is even greater than in the production of castings, as the metal from the steel furnace has to be cast in ingots, of which 20 to 25 per cent. is cut off as waste, before being rolled into bars and billets for stamping purposes.

Our 1000 tons of iron ore take 610 tons of coal and 200 tons of limestone before it can produce sufficient material to make 124 tons of stampings. As stampers we can only govern the loss from the receipt of the bars or billets until the completed forging or stamping is actually in being. The actual loss between the weight of the finished stamping and the steel bar or billet purchased naturally varies with the type of stamping that has to be produced, but, if serious, and I may say scientific attention is given to the problem of losing as little material as possible in the flash and tag ends, much can be done to reduce the wastage.

A modification of stamping technique is required so that a minimum of surplus metal must be left on the stamping instead of the usual allowance required to enable the machinist to get under the skin of the metal, and further, it may be necessary to modify the stamped shape in order to accommodate the part in the squeezing dies.

The Press Shop.—The press shop is another very important department in any automobile factory, and especially in those firms manufacturing their own bodywork. Here, again, the waste of expensive materials seems appalling when viewed over a yearly period, and deserves much more attention than it usually receives.

In the Austin works we use 16,000 tons of sheet metal annually, the price varying in accordance with gauge and specification from £13 to £22 per ton. But as the majority of this material is used for the shell structure of the body, which requires the most expensive grade of sheet, the average works out at about £20 per ton, and from this it will be seen that our yearly bill is approximately £320,000.

Of this we scrap and throw away 35 per cent., *i.e.*, to the value of £112,000, for which the scrap merchant only gives us £7000. In other words, we discard £105,000 worth of this material and receive nothing in exchange!

A 35 per cent. waste is generally considered a satisfactory percentage in a press shop, but this figure must be somewhat humiliating to those who pride themselves on their efficiency.

The actual percentage of scrap, due to faulty work, is comparatively small, say, 3 to 5 per cent., the remainder being the waste due to the process itself and in having to blank awkward sized pieces from square or oblong sheets.

By a more scientific plotting out of pressings and intelligent use of off-cuts a great deal of material can be saved, and since this paper was commenced a reduction in this waste percentage has actually been made in our own works.

The greatest advance, however, can be made in a closer *liaison* between the press-tool maker and the designing office. Too great stress cannot be laid upon this, as success or failure of economical press work manufacture can be attributable to the close co-operation or otherwise of these two important departments.

The Paint Shop.—I only wish to introduce a short paragraph on the waste that occurs in the motor car paint shop.

After great difficulties I succeeded in getting the correct weight of a 7 H.P. saloon body before and after painting. The actual amount of painting materials and stores issued for each body was 22 lb., and it was found that the materials which finally adhered to the finished body weighed only 2 lb.! The greater proportion of this loss, of course, is accounted for by the fact that the materials used in painting are to a very great extent volatile in their nature, but the extraordinary disparity has given us, as the French say, "furiously to think," and here again a noticeable improvement has been made since these facts were established.

RESEARCH.

Many of the problems which I have considered could be solved by intensive study and the preparation of careful statistics in the individual works, the chief point being the discovery of where the greatest wastage is occurring. Some of the problems, however, are so complicated and involve such a long study that they cannot be tackled by any one firm, and it is here that the great value to the industry of the Research and Standardisation Committee will be found. In the recent research on cylinder wear, for instance, it has taken about eighteen months of intensive study and gradual elimination of the many variables to discover the most probable cause of the trouble, and it may even now be some time yet before a cure can be definitely claimed. There are few firms who could afford to wait such a long time for any showing, and their Research Department would be constantly being pushed by the directorate for results, whereas the Research Laboratory at Chiswick can pursue their investigations free of any such commercial urge. The Committee certainly deserves the fullest support of all manufacturers.

I may remind our members that politics *never* assisted in lowering costs of production. Politics always tend in the opposite direction, and we have to fight hard and continuously for our industrial existence.

Our salvation lies within ourselves and ourselves alone. Rises in world commodity prices may be politically sound and furnish good propaganda for a return to prosperity—minimum wages and shorter hours of work may be forced upon us, and perhaps, *quien sabe*, such alterations in our economic and industrial outlook may be eminently sound and morally acceptable, but every move in this direction must be met and counterbalanced by engineering science. And, finally, I state in all earnestness, that progress in the automobile industry can only be maintained and increased by strenuous and continuous efforts on our part, by science and sound technique of manufacture, to reduce the cost of production to such an extent as to allow us to establish and maintain the enormous growth of business which we and the world at large have every right to expect.

SIXTY YEARS AGO.

IT was recently asserted in all solemnity that one of Columbus's ships was still in existence and actually in service as recently as the 1890's. Historically there is no evidence which might be advanced to disprove the tale. On his four voyages of discovery Columbus employed a total of thirty vessels—or perhaps twenty-nine, for the "Nina" seems to have taken part in the second as well as the first voyage. In addition to these vessels under Columbus's own command, numerous supply ships were despatched from Spain during his lifetime, which, although in charge of subordinates, might still reasonably be called his. Of the fate of all these vessels our knowledge is not sufficiently complete to enable us to assert positively that none did or could have survived until the end of last century. The physical improbability of such survival is, however, so great as to amount almost to complete certainty that the tale is false. Possibly it arose as a result of some self-deception on the part of an impressionable person who saw afloat, a few years only after it had been built, one of the replicas of the great discoverer's ships constructed in connection with the celebrations of the four hundredth anniversary in 1892. Credulity is apt to be strained by stories concerning the survival of old ships. We can, however, readily believe that sixty years ago there still existed in a seaworthy condition a ship built in 1764. This vessel, the barque "Truelove," was, according to a note in our issue of October 10th, 1873, built on the Delaware, probably at Kensington. She was constructed for owners residing at Hull, England, and in 1873, under the command of Captain Thomas Wetherill, was still sailing from that port. For forty-seven years she had been engaged in whaling in the northern seas. She was of 296 registered tons and, in spite of her 109 years, had never required any considerable repairs. Her original timbers, it was stated, appeared to be as sound as on the day she left the stocks. This last statement is perhaps the most interesting fact recorded about the old vessel. When we hear tales of the survival of ancient ships we ought, before giving them full belief, to inquire to what extent the fabric which has survived is the original structure and how much of it is of less remote age. The "Truelove" has doubtlessly now disappeared from the seas. The "Victory," built about the same year, survives, but of her original timbers little remains following the rebuildings which she experienced during her active service, the vandalistic reconstruction of the Victorian period, and the careful loving restoration work of our own day.

SOUTH-EASTERN Nebraska Power District, plans for which have been approved by the State Department of Public Works, would involve 600 miles of transmission lines for rural service to farmers unable to secure energy from existing companies.

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* Extracted from the Presidential Address to the Institution of Automobile Engineers in London, October 3rd.

Resistance to Wear of Nitrogen-Hardened Cast Iron.*

By J. E. HURST (Sheffield).

Some properties of an aluminium-chromium alloy cast iron and its behaviour when subjected to the nitrogen-hardening process have been described by the author in a previous paper.† It was shown that alloy cast irons of this type, when exposed to an atmosphere of ammonia gas under the conditions of the commercial nitrogen-hardening process, undergo a surface-hardening effect. A maximum surface hardness of approximately 1000 Firth diamond hardness was obtained, with a depth of penetration of the hardening effect of 0·018in.

The most important applications of cast iron surface-hardened in this manner are those in which the conditions call for resistance to wear. Of these, cylinders and cylinder liners for various types of engines, pumps, and compressors form a group in which the resistance to wear is a property of considerable industrial importance. Accordingly, the experiments on the resistance to wear of nitrogen-hardened cast iron were arranged to study the behaviour of these materials under wear conditions such as exist in internal combustion engine cylinders. It is necessary to point out that these experiments are not concerned with the investigation of the nature and causes of cylinder wear in such engines, but solely with the determination of the comparative resistance to wear of nitrogen-hardened cast iron under these conditions.

In deciding upon the experimental procedure, it was considered that the available types of abrasion wear-testing machines were not likely to give results which would be of value in determining the comparative resistance of materials to cylinder wear. It was arranged therefore to make experimental determinations under actual engine cylinder conditions. Whilst by this method actual industrial conditions can be duplicated with certainty, the tests are of prolonged duration, since it has been found that considerable engine running or mileage is necessary to provide wear figures of a sufficiently decisive character. These experiments with the object of determining the comparative resistance to wear of nitrogen-hardened cast iron were commenced in the early part of the year 1929, and have been in continuous progress for practically four years.

Experimental Procedure.

The experimental programme decided upon involved the determination of comparative rates of wear in a stationary engine installed in the works. In view of the fact that results obtained from stationary engines are not necessarily similar to those obtained from engines running under actual service conditions, the experimental programme was augmented by the inclusion of similar tests on engines actually in service.

The stationary engine tests were carried out on a Leyland four-cylinder 4in. bore petrol engine of the standard type as used in one of their vehicles. This engine, mounted on a suitable frame, was coupled through the clutch direct to a D.C. current generator. The current generated was taken in parallel with the main works D.C. supply at 230 V, and provision was made in the switchgear to isolate to the test engine those sections of the works plant which would provide a steady load for the generator. In addition, the engine was fitted with a governor.

All the tests were carried out on the material in the form of cylinder liners of the type known as dry liners. These dry liners were pressed into the bores in the cylinder block suitably machined to receive them. They were retained in position by reason of the circumferential stresses due to the "interference fit" allowance provided. The full dimensions of the test liners are shown in Fig. 1. The methods of fitting and the interference fits adopted followed the common practice of lining such engines for ordinary industrial service. Every precaution was taken to ensure regularity and uniformity in the methods and details of the fitting and finishing operations. The bores of the cylinder liners were rectified and brought to standard dimensions by grinding or honing after the liners had been pressed into position in the cylinder blocks.

For test purposes the engine was provided with special aluminium alloy pistons made under controlled conditions from the same cast of alloy. The chemical composition and hardness of this, determined on a sample taken from an actual piston, were as follows :—

Copper	2·0%
Zinc	Nil
Iron	1·48%
Nickel	1·02%
Silicon	1·22%
Magnesium	1·46%
Titanium	0·14%
Brinell hardness	75·5 to 82 Firth (120-kg. load, 4 mm. ball)

The piston rings and scraper rings were specially prepared from a series of centrifugally cast piston ring drums of uniform composition and properties. The rings used for each test were selected as giving a uniform radial pressure. The chemical composition and properties of the piston ring material are given below, and were determined on rings taken from the actual drums used :—

Total carbon	3·23%
Combined carbon	0·65%
Graphite	2·58%
Silicon	2·07%
Manganese	0·92%
Sulphur	0·06%
Phosphorus	0·70%
Nickel	Nil
Chromium	Nil
EN value	$16 \cdot 8 \times 10^6$ lb. per sq. in.
Tensile strength	19·7 tons per sq. in.
Brinell hardness	238

The procedure followed in an individual test consisted of fitting up the four bores of the engine with liners. In one bore a liner of one of the standard materials was fitted, and in the remaining three bores were fitted liners of the materials to be tested. The engine was then run under steady, approximately full-load conditions for a given number of revolutions. Each unit test consisted of a period of 40×10^6 engine revolutions. This period corresponds to approximately 10,000 miles of road travel of this particular engine on the basis of an average of 4000 revolutions per mile, when in the vehicle for which it was designed. All tests were carried out for this or multiples of this period.

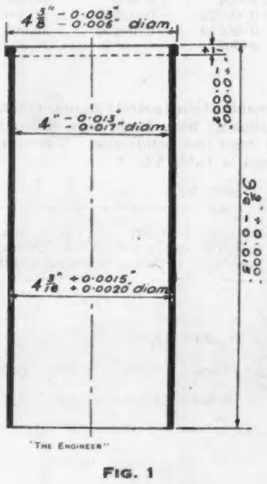
$4\frac{3}{8}$" − 0·003" − 0·005" diam.
4" − 0·013" − 0·017" diam.
$4\frac{3}{16}$" + 0·0015" + 0·0020" diam.
$\frac{1}{2}$"
− 0·000 − 0·004
$9\frac{3}{8}$" + 0·000 − 0·015
"The Engineer"

FIG. 1

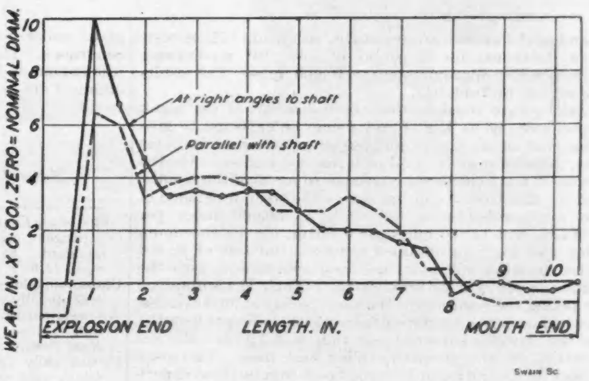

FIG. 2

The amount of wear in each cylinder bore was determined by a comparison of the maximum diameter after the test with the original diameter of the cylinder bore. This difference in diameter is regarded as the maximum wear, and following a common and well-understood practice in cylinder wear measurement is expressed in miles per thousandth of an inch of wear. In the case of the stationary engine tests, this value is obtained by converting the total revolutions into miles, using the relationship referred to previously. The total miles divided by the maximum wear expressed in thousandths of an inch gives the wear value. Expressed in this form the results are comparable with other cylinder wear measurements taken under commercial conditions.

Table I.—*Materials Used for Cylinder Wear Tests.*

Material.	Treatment.	Exp. No.	Chemical composition.										Mechanical properties.		
			T.C. %.	Graph. %.	C.C. %.	Si. %.	Mn. %.	S. %.	P. %.	Ni. %.	Cr. %.	Al. %.	*EN* value. Lb. per sq. in. × 10⁶.	Tensile strength. Tons per sq. in.	Brinell number.
Standard centrifugal cast iron	As cast	Blank, and 2 to 4	3·32	2·64	0·68	2·11	0·88	0·07	0·69	—	—	—	16·9	20·5	238
Chromium cast iron, centrifugally cast	As cast	7 to 10	3·37	2·65	0·72	2·28	0·81	0·06	0·70	—	0·41	—	17·1	21·3	260
	O.-H. and T.	Riley	3·40	2·65	0·75	2·31	0·72	0·06	0·65	—	0·45	—	15·9	22·8	488
Nickel-chromium cast iron, centrifugally cast	O.-H. and T.	6-cyl. Wet liners	3·35	2·69	0·66	2·08	0·70	0·06	0·62	1·21	0·48	—	16·1	22·7	502
Nitrogen-hardened cast iron, centrifugally cast	—	2 to 4	2·36	1·10	1·26	2·44	0·72	0·07 Max.	0·10 Max.	—	1·32	1·01	22·7	26·2	980
	—	7 to 10	2·65	1·10	1·55	2·58	0·61	,,	,,	—	1·69	1·43	23·0	28·9	1050
	—	Riley	2·24	0·74	1·50	2·02	0·85	,,	,,	—	0·69	1·80	22·9	27·5	1050
	—	Star	2·29	1·12	1·17	2·25	0·78	,,	,,	—	0·75	1·79	22·5	29·1	989

The measurement of the cylinder bore diameters was made by means of a two-point cylinder bore measuring gauge of a pattern in common use for the purpose. The dial gauge reads differences in bore diameters direct to a graduated accuracy of 0·0005in., and the fraction 0·00025in. is quite easily estimated. In actual measurement the cylinders are explored by means of the instrument to find the maximum diameter. This is to be found generally at or near the diameter at right angles to the crank shaft on a plane passing through the top limit of piston ring travel. In addition to recording this maximum diameter, measurements were made at successive planes, ½in. apart, down the full length of the cylinder bore. The change in these diameters due to wear, expressed in thousandths of an inch and plotted, yields a complete cylinder bore wear diagram, of which a typical example is illustrated in Fig. 2. These curves show clearly the location of the maximum wear, and for the purposes of this comparative investigation the maximum wear values only have been used.

Materials.—Four standard types of materials have been used as a basis of comparison as follows :—

(1) Plain, unalloyed centrifugal cast iron complying with B.S.I. Spec. 4K6.

(2) Chromium alloy cast iron, centrifugally cast, in the as-cast condition.

(3) Chromium alloy cast iron, centrifugally cast, in the hardened and tempered condition.

(4) Nickel-chromium alloy cast iron, centrifugally cast, hardened and tempered to a Brinell hardness of 450 to 500.

The chemical composition and mechanical properties of these materials, determined in each case on specimens taken from the actual cylinder-liner castings, are included in Table I. In the same table particulars of the nitrogen-hardened cast irons used in each of the experiments are recorded.

Blank Experiments.—At the outset of the experiments it was considered advisable to ascertain the degree of uniformity of the maximum wear of the cylinder bores in each of the four bores of the engine. For this purpose the engine was equipped with four of the standard plain unalloyed centrifugal cast liners, standard pistons and piston rings. After 40×10^6 revolutions (10,000 miles) the maximum wear values were determined. The results are given below for each of the cylinder bores, starting from the radiator end of the engine :—

Bore No.	Max. diametral wear, inch.
1	0·00125
2	0·002
3	0·002
4	0·00175

Cylinder bores Nos. 2 and 3 gave uniform results, whilst bores Nos. I and 4 indicated a slightly less amount of wear to the extent of 0·00075in. in bore No. 1. This tendency for bores Nos. 1 and 4 to show a slightly lower wear value may be borne in mind in considering the further test results.

Experimental Results.

Stationary Engine Tests.—In the stationary engine trials Nos. 2, 3, and 4, the results of which are summarised in Table II., the engine was equipped with a liner of standard unalloyed centrifugal cast material in bore No. 3, and a nitrogen-hardened cast iron liner in bore No. 2. These bores were chosen for this test as having given uniform wear in the blank experiment. The chemical compositions and properties of these materials are given in Table I. The engine was opened up for examination and wear measurement after 10×10^6, 40×10^6, and 120×10^6 revolutions, corresponding to the approximate

Table II.—*Stationary Engine Tests Nos. 2, 3, and 4.*

Bore No.	Material.	Maximum wear in inches after—			Wear in miles per 0·001in. after 120 × 10⁶ revs.
		10 × 10⁶ revs.	40 × 10⁶ revs.	120 × 10⁶ revs.	
2	Nitrogen-hardened cast iron	+0·00025	+0·00025	+0·00125	24,000
3	Standard unalloyed cast iron	+0·00025	+0·0005	+0·0025	12,000

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* The Iron and Steel Institute, September 14th.

† *Journal* of the Iron and Steel Institute, 1932, No. I., page 223.

mileages of 2500, 10,000, and 30,000 respectively. The engine was run at an average speed of 1600 r.p.m. when running under full-load conditions and developed under these conditions an average current of 120 ampères. The engine was equipped with standard aluminium alloy pistons, piston and scraper rings. The maximum wear results are given in Table II.

A further series of stationary engine tests, Nos. 7, 8, 9, and 10, were made with the object of determining the resistance to cylinder wear of nitrogen-hardened cast iron in comparison with that of chromium alloy cast iron. The engine was equipped with two further nitrogen-hardened cylinder liners and two liners of centrifugally cast chromium alloy cast iron. The compositions and properties of these materials are recorded in Table I. The engine, equipped with standard aluminium alloy pistons, piston and scraper rings, was run under conditions similar to the previous tests, and was opened up for examination at the various stages recorded. These tests were continued for a period of 160×10^6 revolutions, corresponding approximately to 40,000 miles. The results are set out in Table III.

Table III.—*Stationary Engine Tests Nos.* 7, 8, 9, *and* 10.

Bore No.	Material.	Maximum wear in inches after—				Wear in miles per 0·001in. after 160×10^6 revs.
		40×10^6 revs.	80×10^6 revs.	120×10^6 revs.	160×10^6 revs.	
1	Nitrogen-hardened cast iron	+0·00075	+0·00075	+0·001	+0·001	40,000
2	Chromium cast iron	+0·00125	+0·002	+0·00325	+0·00325	12,300
3	Nitrogen-hardened cast iron	+0·00075	+0·00075	+0·00125	+0·00125	32,000
4	Chromium cast iron	+0·00125	+0·001	+0·002	+0·0025	16,000

Taking into consideration the indication of the blank experiment, bores Nos. 1 and 4 may be expected to give somewhat higher results, and the values obtained for bores Nos. 3 and 4 may be used as a fair comparison. On the whole, it was considered advisable to average the results, and on this basis mean values for the wear resistance of the nitrogen-hardened cast iron of 36,000 miles per 0·001in., and 14,150 miles per 0·001in. for the chromium alloy cast iron are obtained after the full test of 40,000 miles duration. A more accurate comparison with the results obtained in the previous tests (Table II.) is obtained by taking the results over the same period of 30,000 miles, in which case the mean results are 27,000 miles per 0·001in. for the nitrogen-hardened cast iron, and 12,125 miles per 0·001in. for the chromium alloy cast iron. The mean values for the nitrogen-hardened cast iron in these experiments confirm those obtained in the previous experiments (Table II.), and they show also that the chromium alloy centrifugal cast iron gives results very little different from those of the unalloyed centrifugally cast material.

Road Tests.—In the two road tests recorded, the resistance to wear of nitrogen-hardened cast iron was determined in comparison with chromium alloy and nickel-chromium alloy cast irons in the hardened and tempered condition. The composition of the materials used are recorded in Table I., and the hardened and tempered materials were quenched in oil from 875 deg. Cent. and tempered in a salt bath at 375 deg. Cent.

In the first of these two tests a Riley six-cylinder car was used and fitted with dry liners, three of nitrogen-hardened cast iron and three of hardened and tempered chromium alloy cast iron. The fitting of the liners was carried out under the same conditions as in the case of the stationary engine. The engine was run under ordinary road service conditions for a total distance of 44,500 miles, and the wear test results then obtained are given in Table IV.

Table IV.—*Road Tests (Riley Six-cylinder Car).*

Bore No.	Condition of material.	Maximum wear after 44,500 miles, inch.	Miles per 0·001in. wear.
1	Hardened and tempered ..	+0·0115	3,870
2	Nitrogen hardened	+0·0085	5,250
3	Hardened and tempered ..	+0·010	4,450
4	Hardened and tempered ..	+0·0085	5,250
5	Nitrogen hardened	+0·00275	16,200
6	Nitrogen hardened	+0·005	8,900

For approximately the last 15,000 miles of this test the engine was run on fuel doped with Ethyl Fluid. This was done with the object of ascertaining whether the use of this fuel had any deleterious effect on the nitrogen-hardened material. No sign of any effect was to be observed in any of the cylinder bores.

The amount of wear in each of the nitrogen-hardened liners in this test varied substantially, and most probably this is due to the fact that the liners had been protected from the hardening effect somewhat irregularly. The protection of the internal edge of the liners at the explosion end had been allowed to extend sufficiently far into the bores to be definitely beyond the top limit of piston ring travel. This was quite clearly the case in bore No. 2, and was discovered only when the test was well under way. The mean wear results from this test, however, gave the following values for each of the two materials :—

Chromium alloy cast iron, hardened and tempered : 4,520 miles per 0·001in. wear.
Nitrogen-hardened cast iron : 10,100 miles per 0·001in. wear.

Table V.—*Road Tests (Star Six-cylinder Car ; Wet Liners).*

Bore No.	Condition of material.	Maximum wear after 10,070 miles, inch.	Miles per 0·001in. wear.
1	Hardened and tempered ..	+0·00325	3,300
2	Nitrogen hardened	+0·0005	21,400
3	Hardened and tempered ..	+0·00325	3,300
4	Nitrogen hardened	+0·0005	21,400
5	Nitrogen hardened	+0·00075	14,250
6	Hardened and tempered ..	+0·0035	3,050

The second road test was carried out on a six-cylinder Star engine fitted with "wet" liners. As in the former test, three nitrogen-hardened and three hardened and tempered liners were fitted. The liners were fitted to the engine by the makers. In this case the hardened and tempered liners used were made with a nickel-chromium alloy cast iron of a composition as given in Table I. This test was run under road service conditions over a distance of 10,070 miles, and the results obtained are set out in Table V.

The mean wear values for each of the materials in this test are :—

Nickel-chromium cast iron, hardened and tempered : 3,220 miles per 0·001in. wear.
Nitrogen-hardened cast iron : 19,020 miles per 0·001in. wear.

Summary.

The comparative resistance to wear of nitrogen-hardened cast iron and several other types of cast iron was investigated under internal combustion (petrol) engine cylinder conditions. The experiments were made on a stationary test engine and under road test conditions. The results obtained are summarised in Table VI.

Table VI.

Material.	Total mileage.	Wear, miles per 0·001in.	Total mileage.	Wear, Miles per 0·001in.
Stationary Engine Tests.				
Centrifugal cast iron, standard to B.S.I. Spec. 4K6	30,000	12,000	—	—
Chromium alloy cast iron, centrifugally cast ..	30,000	9,250	40,000	12,300
Nitrogen-hardened cast iron	30,000	24,000	40,000	32,000
Road Tests.				
Centrifugally cast chromium cast iron, hardened and tempered ..	—	—	40,000	4,520
Centrifugally cast nickel-chromium cast iron, hardened and tempered	10,000	3,220	—	—
Nitrogen-hardened cast iron	10,000	19,020	40,000	10,100

A strict comparison of the results can be made only on the basis of equal mileages. At a mileage of 30,000 in the stationary engine tests, a comparison can be made between nitrogen-hardened cast iron, standard centrifugally cast and chromium alloy cast iron. At this mileage the ratio of the resistance to wear of nitrogen-hardened cast iron to standard centrifugally cast iron is as 2 : 1, and to chromium alloy cast iron as 2·6 : 1. At a mileage of 40,000 the ratio of the nitrogen-hardened to the chromium alloy cast iron still remains the same at 2·6 : 1.

In the tests under road conditions, the wear value in miles per 0·001in. of wear is smaller in magnitude than under the stationary engine conditions, but at a mileage of 40,000 the ratio of the nitrogen-hardened to the hardened and tempered chromium alloy cast iron is 2·2 : 1, a figure which is in close agreement with the stationary engine tests. The ratio at 10,000 miles is much higher in favour of nitrogen-hardened cast iron, but in view of the comparatively short duration of this test the results are omitted from this summary.

It is a matter of general interest to note that the differences between the wear values of ordinary cast iron, alloy cast irons, and hardened and tempered cast irons of the types experimented with are not of a very large order.

These results demonstrate clearly the improved resistance to wear under internal combustion (petrol) engine cylinder conditions of cast iron surface hardened by the nitrogen-hardening process. They also may be used to demonstrate the stability of the nitrogen-hardened surface under these same conditions.

In a short test using petrol doped with Ethyl Fluid, no effect due to the presence of the Fluid was observed.

Permission to publish these results has been granted by the directors of the Sheepbridge Stokes Centrifugal Castings Company, Ltd., in whose laboratories these investigations were carried out.

The French Shipping Exhibition.

The annual Salon Nautique, or Shipping Exhibition, which was opened last week on the bank of the Seine in Paris, was originally promoted by boat and engine builders with a view to stimulate public interest in cruising on the extensive system of inland waterways in France, and owing probably to the popular character of the gathering the heavy branch of marine engineering has of late years abstained from taking an active part in it. With the exception of a powerful Lorraine unit with engine of the aviation type and the compression-ignition engines of the Société Als-Thom, the Anglo-Belgian Company of Ghent, and one or two others, the engines are generally of medium and small sizes and the number of them exhibited appears to have declined, as the result, apparently, of the general abandonment of petrol as a fuel for other than the smallest power units. The British industry is represented by the Ruston-Lister Marine Company and by Petters Ltd., of Yeovil. Being the only exhibition of its kind in France, the Salon Nautique offers an opportunity to British marine engine builders to get into touch with a market which should become increasingly important when the economic situation begins to improve. It appeals more particularly to private boat owners, with whom there is obviously less to be done than in some other directions, notably the fishing fleet, to which some prominence is given by the Ministry of the Merchant Marine, and a participation in the Exhibition may be regarded as a useful introduction to shipping generally. The latest figures given by the Ministry of the Merchant Marine of the tonnage of motor propelled fishing boats cover 1931, when it amounted to 55,564 tons. Since then the fishing fleet has fallen on bad times and the fitting of engines to boats has proceeded slowly, though the equipment of existing boats with new engines offers plenty of scope for business in the future. Nowadays, fishing boats have to go much farther afield than formerly.

In the same way, the strike of bargemen on the northern canals has revealed the advantages of self-propelled barges with their greater economy and accelerated transport. At one time several makers, principally Belgian, exhibited engines of the outboard class for the conversion of existing barges, the engine being contained in a well astern with the transmission and propeller carried outboard and generally capable of being raised when passing through locks, but this transformation of barges has not met with any particular success, for the reason that few owners of single barges are able to bear the cost of fitting a power equipment, while there is obviously an economy in building bigger barges for engine propulsion. The canal navigation companies are putting into service a larger number of oil-engined barges, and the ranks of private motor barge owners are increasing, and will continue to increase when the State is able to offer greater financial facilities to owners for the purchase of self-propelled boats. The business is mainly in the hands of Belgian and Dutch engine builders, and French makers are now in competition with compression-ignition types of marine engines, mostly constructed under foreign licence. As an organisation at the ports is essential to the supply of engines for fishing boats, so something of the kind is needed at inland ports for the power equipment of barges.

Small outboard units with petrol engines have become increasingly popular for canal and river pleasure craft, and the number of exhibitors is larger than ever before, including United States, German, Swiss, and French makers, these last-named having abandoned their original types of small units and fallen into line with the universal pattern of outboard propelling gear. So far as boat building is concerned, the Salon Nautique, while not extensive, shows much that is of interest, and some models of yachts are exhibited by John I. Thornycroft and Co., Ltd., who have recently obtained orders for five yachts from French customers.

Methods of fire protection on board ship are an outstanding feature of the exhibits of shipping companies which seek to restore confidence, which was badly shaken by the disasters of the past few years. Several firms showing processes for rendering wood fireproof, and so far as can be judged from the way in which the problem is dealt with there is no question of substituting other materials for wood, except for the use of metallic framework, such as is observable in a ship's cabin shown by the Société Provençale de Constructions Navales as a replica of cabins installed on the latest liners constructed in the company's yards. Everything depends upon the treatment of the wood, linoleum, and textile hangings. Samples are shown of wood impregnated throughout and subjected to successive fires, high temperatures, and the application of the blow-pipe, and holes burnt through wood partitions left charred edges without any outbreak of fire. Varnishes are shown that are claimed to be incombustible. The Chantiers de Penhoët exhibit models of the devices they employ for testing the fireproof qualities of materials and display graphs indicating the number and character of the tests they have carried out during the past eighteen months. They also show systems of metallic supports for electric cables. The last year or so has been devoted to a close investigation by State Commissions and the shipping companies into all possible methods of eliminating the risk of fire on board ship, and it is sought to convince the public that this object has now been attained.

Work recently completed in the way of harbour extensions and improvements is indicated by models of the ports of Cherbourg, Dunkirk, and Boulogne ; representations of the "Normandie," as she will be afloat, impress the public with the progress of the French merchant marine, and models of new cruisers shown by the Ministry of Marine, a model of a testing tank, and other exhibits representing what has been accomplished in the maritime services are well presented as a means of stimulating popular interest in them.

CHADWICK LECTURES.

The programme of Chadwick Public Lectures, which are open to all, starts on Monday, October 23rd, at 5.15 p.m., at the Royal Society of Arts, Adelphi, with a lecture on "Port of London Sanitary Administration," by Mr. P. W. Coombe, a Port Sanitary Inspector who has a fine series of slides to illustrate his subject.

The second lecture will deal with the "Sanitary Arrangements of Mediæval Monasteries." Dr. Percy Flemming has devoted much time and enthusiasm to the study of early monasteries as self-contained units of civil life. He will show on the screen examples of monasterial sanitation as discovered at Canterbury, Westminster, Gloucester, Fountains, Furness, and other abbeys. It will be delivered on Thursday, November 2nd, at 5.30 p.m., in the hall of the Royal Society of Tropical Medicine and Hygiene, 26, Portland-place, W.1.

In the same meeting place, the "Malcolm Morris Memorial" lecture will be delivered on Tuesday, November 14th, at 5.30, by Dr. R. O. Moon, the subject being "Housing and Town Planning in Relation to Public Health."

A variation of the usual type of Chadwick Lectures will be the "Bossom Gift" symposium on "The One-pipe System of House Drainage in Theory and Practice," to be held at the London School of Hygiene, Keppel-street, Bloomsbury, on Tuesday, November 21st, at eight o'clock.

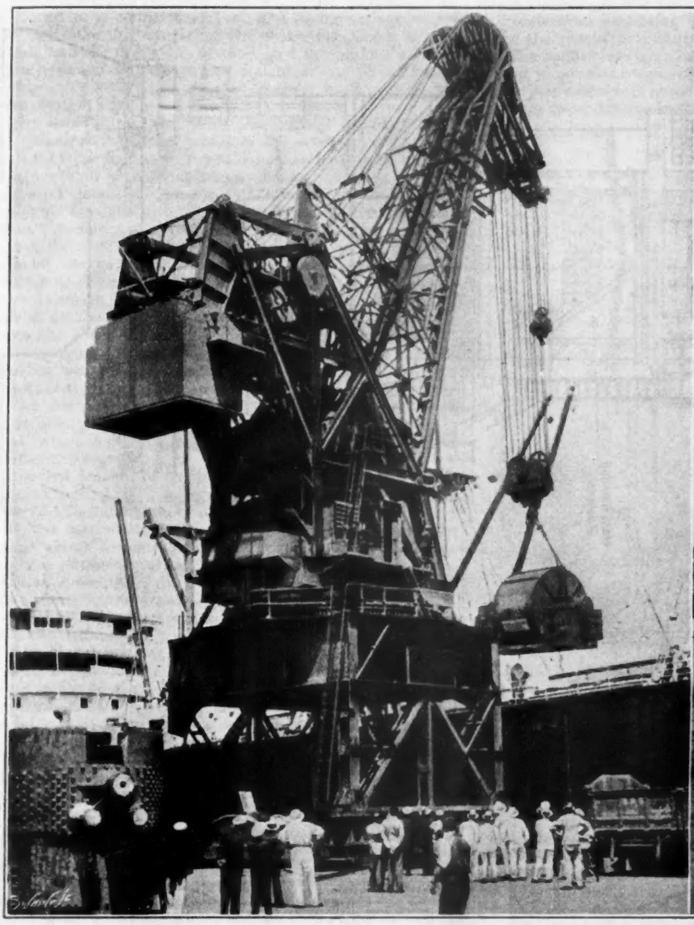
The programme will terminate with an address on "Rural Sanitation," by Mr. J. H. Coste.

A lecture out of London will be delivered by Mr. E. G. Haygarth Brown, formerly of the Ministry of Agriculture, who will discourse on "Standards of Food in Relation to Public Health," at the University of Reading.

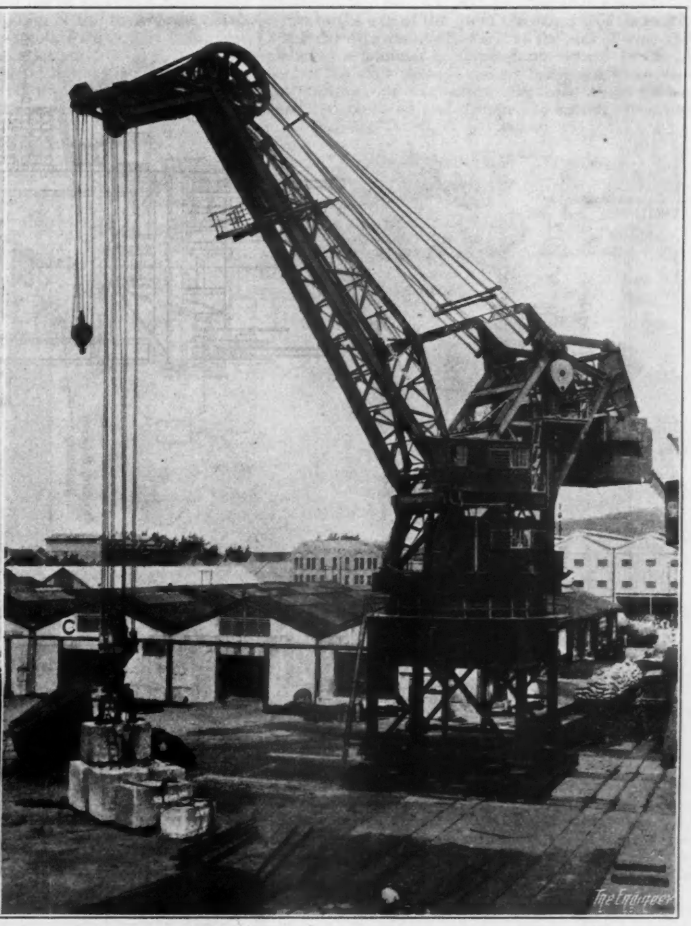
Further particulars of these and future Chadwick Lectures may be obtained from the Secretary, Mrs. Aubrey Richardson, 204, Abbey House, Westminster.

80-TON ELECTRIC LEVEL-LUFFING JIB CRANE

BABCOCK AND WILCOX, LTD., LONDON AND RENFREW, ENGINEERS



LIFTING A 60-TON MOTOR



AN ACCEPTANCE TEST

An 80-Ton Level-Luffing Travelling Crane

◆

ALTHOUGH it is some years since we dealt in full with the special type of level-luffing lever jib crane, designed and built by Babcock and Wilcox, Ltd., of London and Renfrew, one of these cranes was briefly described in our issue of March 30th, 1931. It was a 20-ton portable crane for harbour and railway work. The crane we are about to describe is the largest of its kind yet constructed, having a lifting capacity of 80 tons, and was built to the order of Reynolds, Sons and Partners (Proprietary), Ltd., for the South African Railways and Harbour Administration. After undergoing official tests at the makers' works, it was dismantled and re-erected at Durban, finally tested, and is now available for the service of the port.

As our drawing and engravings indicate, it is arranged to travel on an 80ft. long track of four lines of rails, which are laid at right angles to the face of the quay wall, the actual length of travel of the crane being 53ft. The rails are sunk slightly below the surface of the ground, so that the crane when not required can be travelled away from the quay wall and the ordinary railway track for wagons, which is parallel to the quay side, can be restored by fitting in it removable pieces of rail at the points where it crosses the four-rail crane track. The quay is thus free for the passage of smaller cranes and railway wagons used in working cargoes. This arrangement is indicated in the view on the right reproduced above, which shows the crane undergoing acceptance tests at a point about midway along its track. The view to the left of the same illustration shows the crane in the alongside-ship position, lifting a 60-ton motor.

Hoisting Gears.

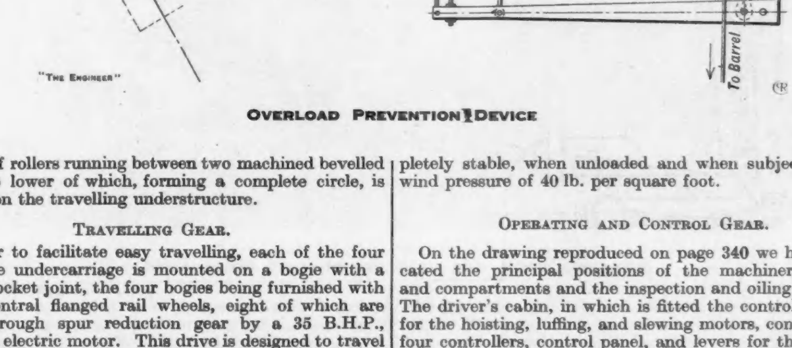
The main hoisting machinery is designed to lift the maximum load of 80 tons at the rate of 5ft. 9in. per minute on the main return block with ten falls of steel wire rope, while a load of 40 tons can be similarly hoisted by means of change speed gear at a speed of 11ft. 6in. per minute. The hoisting rope winds on a mild steel welded barrel, 6ft. diameter and 11ft. 6in. long, which is grooved to receive the rope. An overload prevention device, illustrated by a diagram, and referred to later, is provided in order to ensure that loads above 80 tons cannot be lifted, and also that the maximum load of 80 tons cannot be luffed out beyond a radius of 62ft. 6in.

The auxiliary hoisting return block is designed to lift 20 tons on six falls of rope at 24ft. per minute, or 10 tons at 48ft. per minute, by means of change speed gear. The motors for both the main and auxiliary hoisting motions are 50 B.H.P. series-wound machines, and run at 600 r.p.m. Each of the hoisting controllers, which are of the tramway reversing pattern, has dynamic braking on the lowering side, and, in addition, each motion is equipped with a powerful mechanical brake, apart from the automatic magnetic brake on the motors.

The crane is designed to luff with the full load at 60ft. per minute from minimum to maximum radius, and the luffing machinery comprises a 30 B.H.P. compound-wound motor running at 750 r.p.m., which operates the motion through a train of spur gears.

Slewing Gear.

The crane is arranged to slew at the rate of one-third revolution per minute, through spur and bevel gear reductions driven by a 35 B.H.P. motor running at 650 r.p.m. The main pinion gears with the slewing rack built up of mild steel sections, the teeth being formed from renewable high tensile steel pins with rollers. The motion is provided with a powerful foot-operated mechanical brake and a slipping clutch. The racepath consists of a live ring of rollers running between two machined bevelled paths, the lower of which, forming a complete circle, is mounted on the travelling understructure.


Radius Indicator
Switch A
Switch B
C.L. of Jib
SWITCH A. Maximum Radius Switch Working in Conjunction with Load.
SWITCH B. Minimum Radius Switch.
SWITCH C. Overload Switch.
To Load
To Load
Switch C
Spring
To Barrel
"The Engineer"

OVERLOAD PREVENTION DEVICE

Travelling Gear.

In order to facilitate easy travelling, each of the four legs of the undercarriage is mounted on a bogie with a ball and socket joint, the four bogies being furnished with sixteen central flanged rail wheels, eight of which are driven through spur reduction gear by a 35 B.H.P., 650 r.p.m. electric motor. This drive is designed to travel the crane, without the load, at a speed of 30ft. per minute. A magnetic brake is fitted to the motor and anchor links and shackles are provided which engage with hooks fixed in the concrete foundations, and so enable the crane to be anchored after it has been moved into position at either end of the track. Two portable blocks, 30ft. long, are provided, which are lowered alongside the undercarriage to prevent wagons running into the crane carriage, when it is across the wagon tracks. The bogies on which the crane travels are 3ft. 6in. gauge and the bogie tracks are 27ft. between centres.

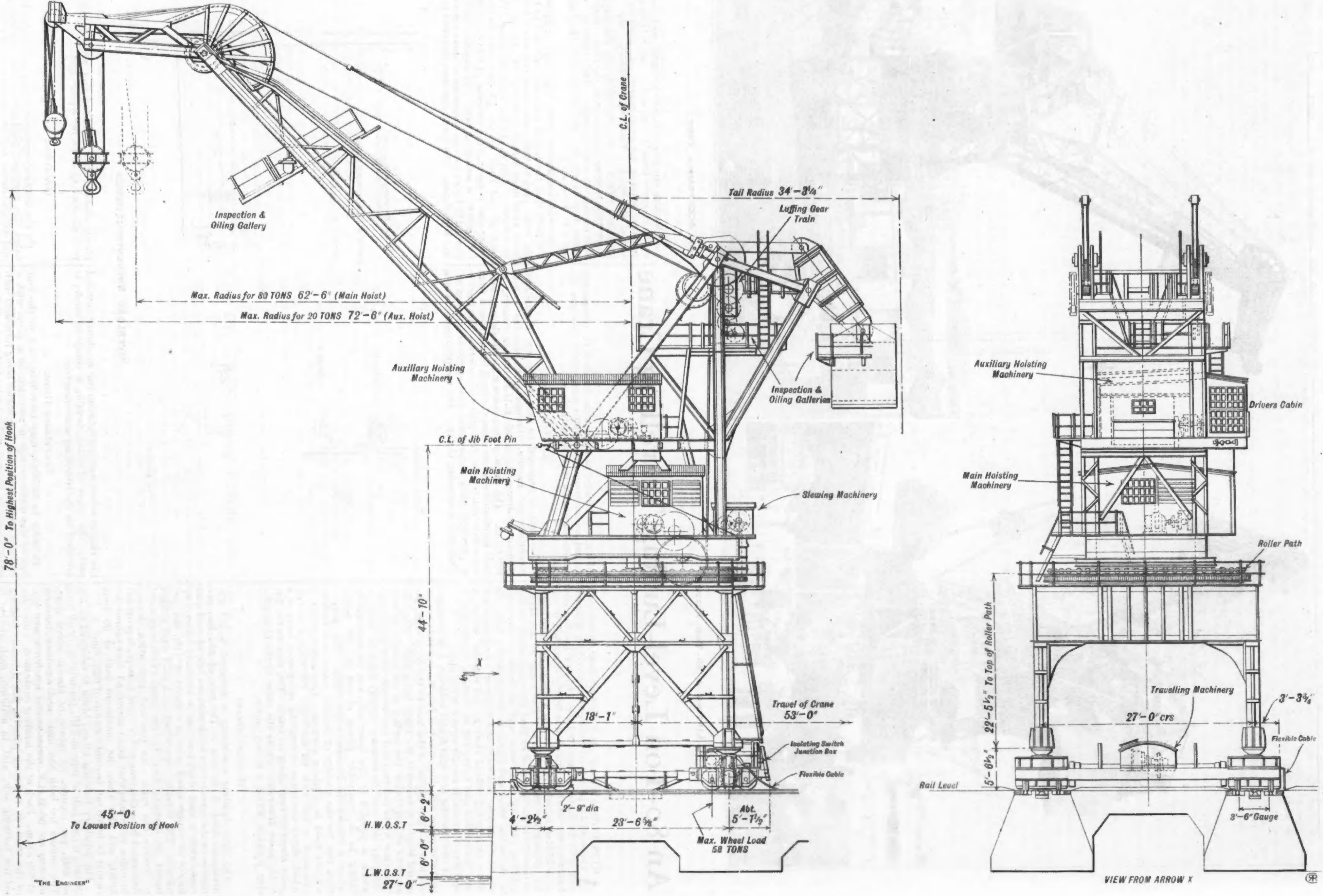
Some idea of the size of the crane may be gathered from the facts that the height from the rail level to the top of the roller path is 28ft., and from the wharf level to the hook when in its highest position 78ft., and the hook can be lowered to a depth of 45ft. below the wharf. The ballast tank at the back of the jib foot may be noted. In order that some existing material at site could be utilised for ballast, a swinging tank was supplied, which holds about 123 tons of scrap, consisting of short lengths of rails and sole-plates. The crane has been designed to be completely stable, when unloaded and when subjected to a wind pressure of 40 lb. per square foot.

Operating and Control Gear.

On the drawing reproduced on page 340 we have indicated the principal positions of the machinery houses and compartments and the inspection and oiling galleries. The driver's cabin, in which is fitted the controlling gear for the hoisting, luffing, and slewing motors, consisting of four controllers, control panel, and levers for the mechanical brakes, is situated about 44ft. above the quay level, and is placed forward of the jib foot, to one side, so that

80-TON ELECTRIC LEVEL-LUFFING TRAVELLING JIB CRANE

BABCOCK AND WILCOX, LTD., LONDON AND RENFREW, ENGINEERS


C.L. of Crane
Tail Radius 34'-3¼"
Luffing Gear Train
Inspection & Oiling Gallery
Max. Radius for 80 TONS 62'-6" (Main Hoist)
Max. Radius for 20 TONS 72'-6" (Aux. Hoist)
Auxiliary Hoisting Machinery
Inspection & Oiling Galleries
C.L. of Jib Foot Pin
Main Hoisting Machinery
Slewing Machinery
78'-0" To Highest Position of Hook
44'-10"
X
18'-1"
Travel of Crane 53'-0"
Isolating Switch Junction Box
Flexible Cable
45'-0" To Lowest Position of Hook
2'-9" dia
H.W.O.S.T
6'-2"
4'-2½"
23'-6⅝"
Abt. 5'-1½"
Max. Wheel Load 58 TONS
L.W.O.S.T
6'-0"
27'-0"
"The Engineer"
Auxiliary Hoisting Machinery
Drivers Cabin
Main Hoisting Machinery
Roller Path
22'-5½" To Top of Roller Path
Travelling Machinery
3'-3¾"
27'-0" crs
Flexible Cable
Rail Level
5'-6½"
3'-6" Gauge

VIEW FROM ARROW X

under all conditions a clear view of the load being handled is obtained.

The auxiliary hoisting gear is accommodated in a machinery house alongside the driver's cabin, the main hoisting and the slewing gears being arranged in houses about the level of the race path, while the travelling gear is placed in a compartment on the undercarriage where the controller for operating the travelling motor is also fitted. All the gearing is of steel, and the pinions and the main hoisting spur wheel were machined out of mild steel blanks. The structure of the crane is built completely from British steel.

The level-luffing gear is of the makers' familiar type, the principal feature of which is the articulated jib lever with its cam and back guys. Another feature of the jib design which our illustrations clearly show is greatly increased clearance underneath the crane, compared with the usual straight jib. The swinging counterbalance also keeps the centre of gravity near the centre post, and well within the race path under all conditions, as the counterbalance moves inwards as the jib moves inwards, and *vice versâ*. It may also be noted that the counterbalance is mounted on a variable arm, and that there is no fixed ballast at the back of the crane, an arrangement which keeps the centre of gravity much nearer to the centre of the revolving bed-plate at any radius and load than is possible with fixed ballast, while the load on the rail wheels is thus equalised and serves to enhance the safety of the crane. The back guys are eight-fold steel wire ropes arranged to lap over a cam on the back of the jib lever, which is given a large radius to ensure freedom from wear of the ropes.

Another feature of the luffing gear is the use of cranks and connecting-rods, an arrangement which was adopted after full consideration of all other systems on the ground that the harmonic action of the cranks automatically brings about a reduction in the speed of luffing towards the ends of the travel, although the motor is running at a uniform speed, and, further, the jib is positively driven in and out by the cranks.

Another advantage claimed for the design adopted is that the balance of the jib is not affected in any way by the load lifted, and it is in perfect equilibrium from maximum to minimum radius; therefore the power required to move the jib is only that needed to overcome the friction of the moving parts, and a 30 B.H.P. compound-wound motor running at 750 revolutions per minute is quite sufficient to luff the jib easily and safely in either direction, whilst sustaining a load of 80 tons at 60ft. per minute. As shown in the drawing, page 339, an arrangement of self-resetting limit switches is fitted in order to cut off the current when the maximum radius of 72ft. 6in. or the minimum radius of 25ft. has been reached.

The power supply is D.C. current at a pressure of 550 volts, and is brought to the crane by a flexible trailing cable, 60ft. long, with a plug which can be fitted into either of two plug boxes arranged along the track.

The size of the crane we have described will be apparent from our illustrations. It was completely erected at the makers' works, on a temporary rail track carried on concrete foundations, and was fully tested in all its motions with a load of 100 tons, in the presence of the inspecting engineer to the High Commissioner for the Union of South Africa. After testing, it was dismantled and shipped to South Africa, where it was erected and tested under the supervision of Lieut.-Colonel J. Dickson, the mechanical engineer to the South African Railways at Durban, and Mr. C. Nicks. Despite the magnitude of the undertaking, the period which elapsed from the landing of the material to the carrying out of the final test was only three months. The work proceeded without a hitch of any kind, except that it was held up for about fourteen days owing to bad weather conditions. All the various parts went together perfectly, and the test, we are informed, was satisfactory in every respect. The new crane now forms a valuable addition to the services of the Port of Durban.

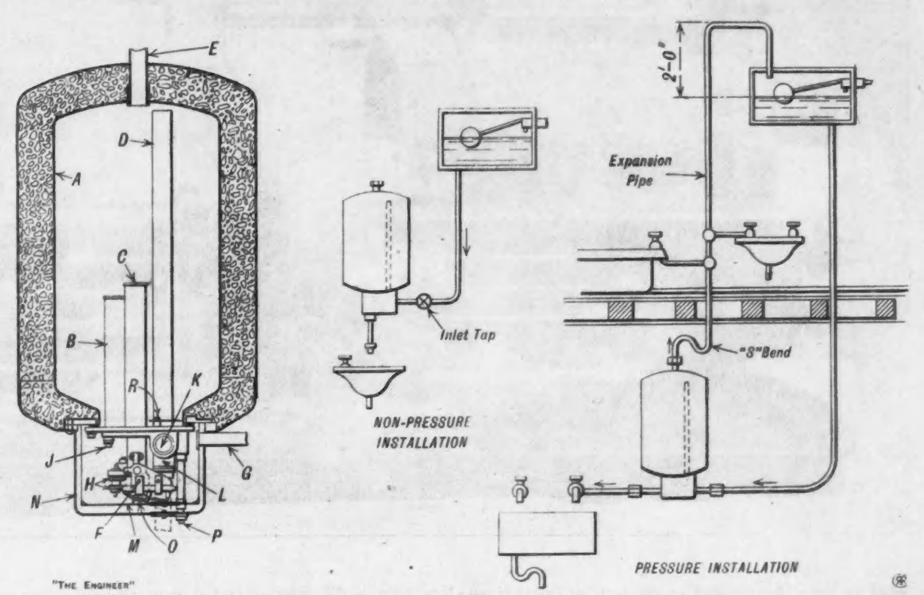
Electric Water Heaters.

Domestic electric water heaters made in sizes recommended by the British Electrical Development Association have been put upon the market by A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne. The standard heaters are cylindrical, but rectangular heaters are also supplied. The range in both cases meets the widest variety of requirements. The rolled sheet copper water container of the cylindrical units has domed ends, all joints being welded. At the top of the container there is an outlet for an expansion pipe, whilst the base is provided with a reinforcing ring which carries the plate supporting the heater and thermostat tube. All surfaces which make contact with the water are heavily coated with pure tin. Inlet and outlet pipes attached to the cast brass apparatus plate have standard threads. The heating element container, and that for the thermostat, are also fitted to this plate, and a screwed plug is provided to enable the tank to be drained. A standard Reyrolle heater unit, consisting of a bobbin shaped porcelain member fixed on a non-rusting central metal rod and resistance wire rated to ensure long life, is used in all cases. By removing two small screws the element can readily be withdrawn from the apparatus without draining the water from the container.

The thermostat consists of a straight invar rod fixed to a brass tube, and the unequal expansion of the two metals causes a mercury switch to trip and make or break the supply circuit. By turning a knurled knob the temperature at which the water is maintained can be varied between the limits of 120–190 deg. Fah. Once the knob has been set for a definite temperature it is retained in position until it is reset. The water container is enclosed in a neat sheet metal enamelled casing and the intervening space between them is filled with granular cork to reduce heat losses to a minimum. Substantial fixing brackets drilled to the standard dimensions recommended by the Electrical Development Association are supplied. All the terminals and connections to the heater and thermostat are properly protected by covers.

The general construction of the cylindrical type of heater will be understood from the section shown in the accompanying illustration, in which A is the inner water container, B the heater tube, C the thermostat tube, D the hot water outlet pipe, E the outlet for the expansion pipe and hot water outlet, F the thermostat mercury switch, G the entry for a ¾in. Simplex cable conduit, H line terminals, J the earth terminal, K the outlet pipe connection, L an alternative outlet pipe and drain plug, M a leatheroid insulating lining, N the thermostat cover, O the thermostat adjusting knob, P the cover fixing nut, and R a baffle plate over the inlet pipe.

As it is not always possible to find a rigid support for a heater just where it is required, a special foundation framework has been designed. It is made of flat mild steel bars and is drilled and tapped to suit specific heaters. The holes for fixing screws can be drilled on site to match points at which a rigid support is possible, such as the wooden bearers of a lath and plaster wall. Alternatively, bolts can be provided for stone or brick walls. The special framework also allows the apparatus to be set perfectly plumb, and when it has once been fixed it can be removed and returned to exactly the same position without damaging the wall. Standard heaters are fitted with two terminals for the supply cable and the protecting covers are designed for cables run in conduit.

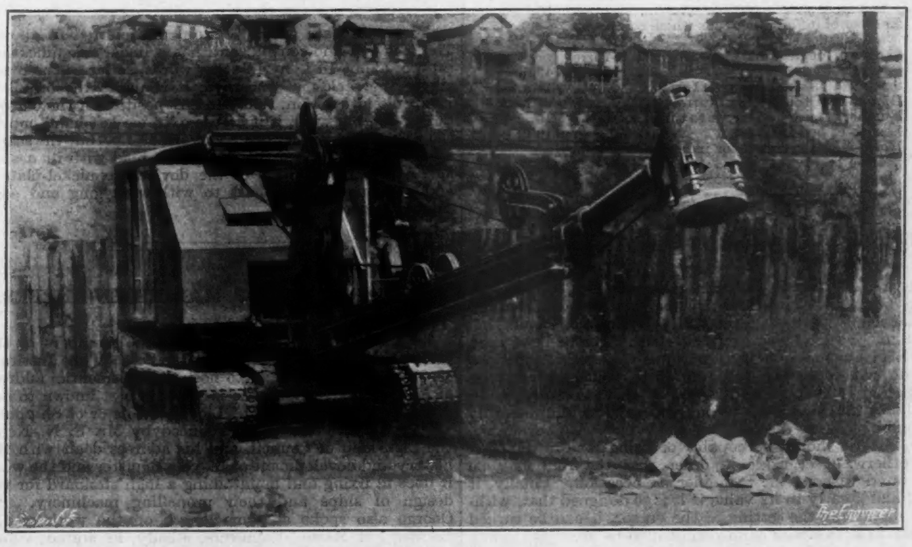


Section Through Electric Water Heater, and Arrangement of Pipe System

Small capacity heaters should be fitted as near as possible to the service point, and as only one outlet is usually required the control tap can be connected in the inlet pipe as shown in the centre illustration. This is known as a "non-pressure" heater installation, as there is no pressure on the water in the heater when the tap is closed. In the case of larger installations with several outlet points the taps are necessarily connected to the outlet pipes and the inlet pipe is taken direct to the heater from the reserve tank, as shown on the right of the illustration. This is known as the pressure system, as the water in the pipes and in the heater is always under pressure.

A Pavement Smasher.

Some time ago we had occasion to refer to a machine which had been developed in this country for such purposes as smashing up pavements and other structures that had to be removed, probably through obsolescence. That machine resembled, in its essential features, a mobile pile driver. Another means of carrying out the same style of work, as well as rock breaking and similar jobs, is illustrated by the accompanying engraving, which comes to us from America.



Excavating Machine Adapted for Rock Breaking

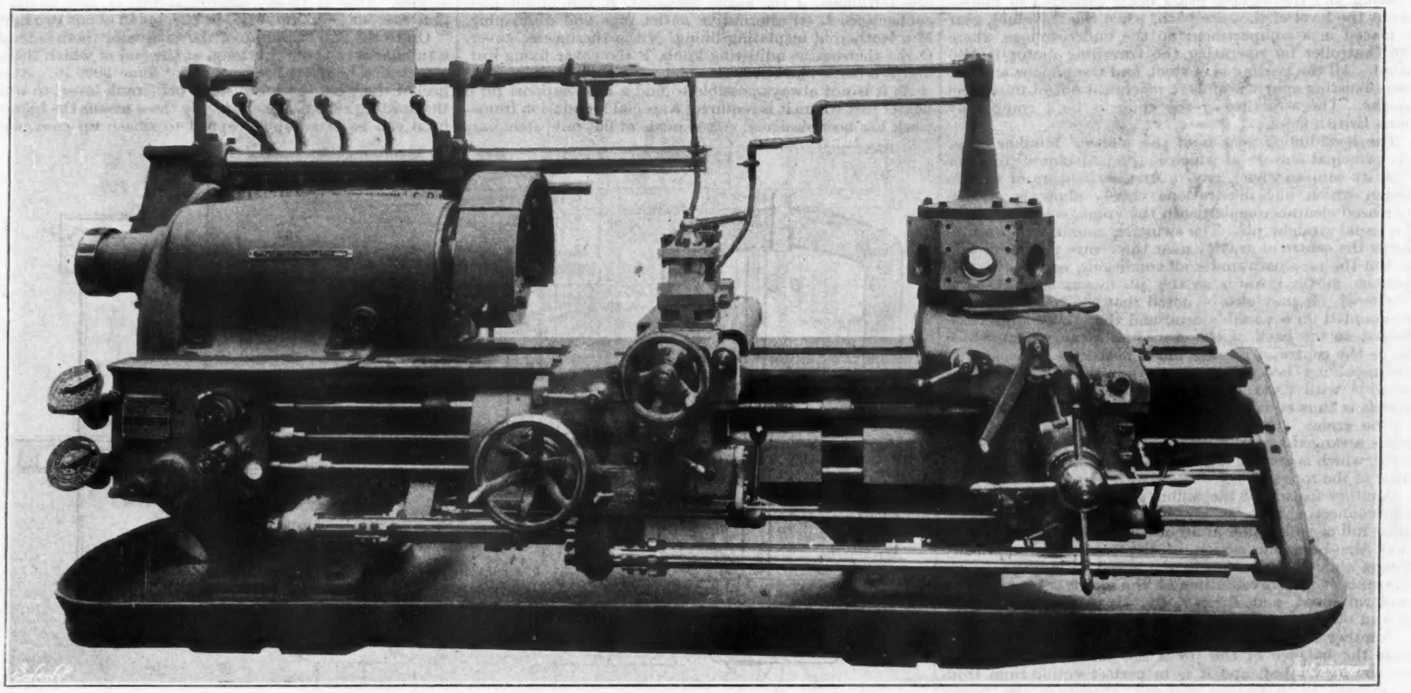
The Keystone Driller Company, of Beaver Falls, Pa., aims at adapting its excavating machines to the utmost variety of purposes, so that, should they be idle in their primary *rôle*, they may be put to work in some other service. One of these transformations is that which we illustrate, and can, it is said, be effected in about two hours.

On to the end of the jib of the excavator there is hinged a tubular arm about 8ft. long, at the end of which there is attached a hammer head weighing some 3000 lb. At the heel of the stalk there is a short bell-crank lever, to which the hoisting rope is attached. By these means the hammer head can be lifted and dropped to smash up pavements, break up stones, and so forth. The free fall of the hammer is facilitated by an easy working clutch on the winch, which is of the V groove type, and the impact of the blow may be accentuated by pulling down on a rope passing beneath the hinge of the arm. We understand that the hinge is of such a design that shocks from the falling hammer are minimised before they are transmitted to the machine. The striking face of the hammer can, obviously, be formed to suit the work in hand. The device is said to be capable of delivering blows from a height of from 5ft. to 10ft. at the rate of twenty a minute.

New Combination Turret Lathe.

Rather less than five months ago we were able to announce that the firm of H. W. Ward, Ltd., of Birmingham, had added another combination turret lathe to the range of such machines it manufactures. The tool we illustrate above is yet another addition, and is known as the No. 8 combination turret lathe. Designed to meet the high-speed heavy-cutting capabilities of modern tungsten-carbide tools, it is especially powerful, but since in many respects it is very similar to other productions of the firm which we have described from time to time, it is unnecessary for us to refer in detail to the various parts. The arrangement of the speed change levers behind the head is retained, together with the mechanism by which a cone clutch in the driving pulley is taken out of engagement and a brake applied to the spindle when one of the levers is in process of being moved. In common with the majority of high-class machines, this lathe is fitted with covered ways. These covers, however, are not of the sliding type, but are held permanently in the one position. Cored passages of a section similar to that of the covers are provided through each saddle. The feed gear-box arranged

NEW COMBINATION TURRET LATHE

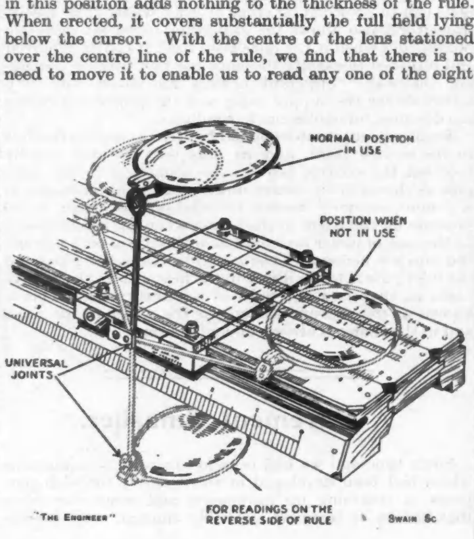


as usual at the left-hand end of the bed, provides three changes of speed for the lead screw, ten changes for the sliding and surfacing feed shafts, and five changes for the turret feed shaft. Safety clutches are included in the feed shafts to protect the machine from accidental damage. A speed change gear on the turret saddle doubles the number of feeds available at this point. Since this change gear has a ratio of about 5 to 1, suitable feeds for such diverse operations as reaming, boring, rough and finish turning can be obtained without altering the setting of the main feed gear-box. All the feed changes can be made while the machine is in motion and the sliding and surfacing and the screw-cutting motions are reversed by the movement of a single lever. The screw-cutting motion is applied to the saddle and is obtained from a detachable leader screw and nut. As the gear-box allows the rotation to be altered in the ratios "equals," two to one, and four to one, with the spindle, it is possible to cut three different pitches with each lead screw. A quick withdraw motion connects the cross slide with the leader nut so that both operate simultaneously. The various parts of the lathe are lubricated by four plunger pumps situated respectively in the headstock, feed gear-box, intermediate saddle apron, and the turret saddle apron. Feed tubes from the pumps in the two saddles spread lubricant on the shears of the bed. Some dimensions of this lathe are given in the following table :—

Height of centre	10¾in.
Swing over bed covers	19½in;
Diameter of chuck which will swing over cross slide..	12½in.
Diameter of chuck or face plate which will swing up to edge of cross slide	17¾in.
Diameter of hole through spindle	3¾in.
Diameter of flange of spindle	10in.
Diameter of driving pulley	12in.
Revolutions per minute of driving pulley ..	600 or 800
Number of spindle speeds in each direction..	16
Swing over top of cross slide of saddle ..	12½in.
Length of longitudinal automatic feed to saddle	43in.
Number of reversible automatic feeds to saddle and cross slide	10
Number of different threads which can be cut with leader supplied	3
Length of longitudinal automatic feed to turret saddle	43in.
Size across flats of hexagon turret..	14in.
Diameter of tool holes in turret	3½in.
Number of automatic feeds to turret saddle ..	10
Length of bed	10ft.
Horse-power required for independent motor drive	15

Slide Rule Magnifying Attachment.

The accuracy with which a slide rule can be read and the comfort with which it can be used are considerably enhanced if the rule is fitted with some form of magnifying system. Various forms of slide rule magnifier have been devised, but most of them are open to certain objections or do not cover the full service to which a magnifier might be applied. The attachment should obviously not be bulky and should cover a considerable field, preferably a field as wide as the width of the cursor. It is desirable, too, that it should be capable of being readily removed or otherwise set aside in order that the rule may be operated without the magnifier on occasion. Finally, it will add greatly to its value if it is so designed that, without disturbing the setting of the cursor, it can be turned about in such a way as to permit it to be used for reading the sine, tangent, logarithm, or other scales on the back of the rule. The magnifier illustrated herewith has just been introduced by A. G. Thornton, Ltd., King-street West, Manchester, and is applicable to the various patterns of P.I.C. rules made by the firm, including the log-log slide rule with differential scale described in our issue of April 7th, 1933. The device is attached to the top edge of the cursor. It consists of a circular lens, 1⅝in. in diameter, mounted on a ball joint at the end of a rod. A similar ball joint at the other end of this rod is employed to attach it to the edge of the cursor. Adjusting screws are provided to enable the friction at the ball joints to be regulated. The lens has an almost completely universal movement. It can be folded down flat against the face of the rule when it is not required, and in this position adds nothing to the thickness of the rule. When erected, it covers substantially the full field lying below the cursor. With the centre of the lens stationed over the centre line of the rule, we find that there is no need to move it to enable us to read any one of the eight scales on the face of the log-log rule referred to above. The lens is plano-convex, and has a linear magnification ratio of about 1 : 1·7. In other words, so far as the reading of the scales is concerned, it converts the ordinary 10in. rule into a 17in. rule. In any position of the cursor, but preferably when it is at the extreme left-hand end of the rule, the magnifier can be inverted to permit the scales on the reverse side of the slide to be read with its assistance. The metal parts of the device are nickel-plated, and are sufficiently robust to withstand long and continuous service.



SLIDE RULE MAGNIFIER

THE INSTITUTE OF MARINE ENGINEERS.

There was a large gathering of the members of the Institute of Marine Engineers at the home of the Institute on Tuesday evening last, to hear the presidential address of Sir George Higgins, who is perhaps best known to our readers as the Chairman of Lloyd's Register of Shipping. The new President was introduced by Mr. S. N. Kent, the Chairman of Council, and his address dealt with the history and development of Lloyd's Register and the work it does in fixing and maintaining a high standard for the design of ships and their propelling machinery. Sir George also spoke at some length on the work of the Institute of Marine Engineers, a body, he stated, which might well be defined as the representative organisation of the marine engineering profession. He congratulated the Institute on its Royal Charter and the efforts it was making to bring its standard of membership in line with those of the senior chartered institutions which represented other branches of engineering activity. The principal papers to be read during the forthcoming session include one by Dr. Ormandy on "Oil from Coal," one by Mr. Robert Sulzer on "Welding for Pressure Vessels," and one by Mr. Stanley S. Cook on "Geared Turbine Installations for Tramp Steamers," all of which, the President stated, would deal with new and important developments in marine engineering work.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. Leonard Clarke, A.M.I. Mech. E., for many years chief draughtsman of the British Electric Transformer Company, Ltd., Hayes, Middlesex, has severed his connection with that company.

The "Sentinel" Waggon Works, Ltd., of Shrewsbury, have acquired the business of Garner Motors, Ltd., and the Garner range of light petrol vehicles will thus become complementary to the "Sentinel" Steamer range. To cope with this additional work the "Sentinel" plant at Shrewsbury will be extended.

The Brush Electrical Engineering Company, Ltd., Loughborough, announces that Mr. Norman A. Collard has been appointed assistant general manager. Since the war Mr. Collard has been associated with the sales department of Metropolitan-Vickers Electrical Company and the Stirling Boiler Company, Ltd. He joined the sales staff of the Brush Company in January, 1931.

Waygood-Otis, Ltd., announces that Mr. Henry C. Walker, who has been with the company for nearly seventy years, and has been chairman since the formation of the company, is retiring on account of his age, which is just on eighty-three. Mr. D. W. R. Green has been elected chairman in his place, and as a consequence has relinquished his position of managing director, which he has held for about twenty years. Mr. W. W. Weaver, who has been appointed managing director, has been with the company something like twenty-seven years. Messrs. H. Harmsworth and C. H. J. Day, both of whom have been directors for many years, are retiring.

CONTRACTS.

Bastian and Allen, Ltd., Hanwell, have received the contract for the thermal storage system for heating the new showrooms for the Swindon Electricity Department, which are now being built.

Sir Lindsay Parkinson and Co., Ltd., have placed with K. L. Kalis, Sons and Co., Ltd., of London, a contract for dredging and other work involved in the completion stage of the new Grimsby fish dock.

C. A. Parsons and Co., Ltd., Newcastle-on-Tyne, have received an order from the Australian Paper Manufacturers, Ltd., of Sydney, for a turbo-alternator of 3000-kW capacity, complete with surface condensing plant. The set, which is of the "Uniplane" non-basement type, will generate current at 3300 volts and will work with steam at 400 lb. pressure superheated to 700 deg. Fah. Messrs. Parsons have also received orders for two complete geared turbo-generating sets for British paper mills. The turbines in both cases are arranged to pass out steam for heating purposes. One of these sets is of special interest for the reason that the turbine will drive both a 1250-kW alternator and a 1000-kW direct-current generator. Each generator will be ventilated on the closed circuit system.

The Portuguese Destroyer "Lima."—On August 4th we described and illustrated the destroyer "Vouga," which is the first of a flotilla of five designed and constructed by Yarrow and Co., Ltd., of Scotstoun, Glasgow, for the Portuguese Government. She was delivered in June and has created a most favourable impression. During the last fortnight all the trials of the second destroyer "Lima" have been successfully completed, and highly satisfactory results have been obtained in regard to both full speed and fuel consumption. The "Lima" is a sister ship to the "Vouga" and has a displacement of about 1600 tons. Her propelling machinery consists of high-pressure turbines, steam being supplied by Yarrow patented water-tube boilers working at a pressure of 400 lb. per square inch.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Steel Cartel and British Merchants.

The difficulties of the European Steel Cartel have scarcely been mitigated by the events of the past few weeks. Merchants in Germany, France, Holland, Belgium, and Great Britain are still displaying hostility towards the new sales policy of the Cartel and its selling comptoirs. Under the Cartel's reorganisation scheme, the works' agents became merchants standing in a favourable position with their works, and naturally have had to try and do a direct business with consumers. Their efforts in this direction have aroused such feeling amongst merchants of long standing that a number of them now place their orders direct with the Continent. This state of affairs has prevailed for some time, but recently negotiations were set on foot with the object of reaching an agreement. The merchants have suggested that the works should reinstate their representatives in Great Britain as genuine works' agents who would be permitted to sell only on net cash f.o.b. terms. The negotiations between the Cartel and the merchants have been proceeding on other questions, and it is understood that they are in a fair way to being brought to a successful conclusion. Apart from the request of merchants referred to above, the Continental steel works have withdrawn their demand that merchants should sell only Continental steel to the exclusion of British material, and have also dropped their condition that the merchants' books should be open to the inspection of the Cartel representatives. Further complaints of the merchants that the Continental steel works will no longer sell them semis, but sell direct to consumers in this country through their selling organisations here, is under discussion, but apparently in this matter the Continental steel makers have adopted the attitude that the present arrangement cannot be altered. On the whole, however, the British merchants seem to be making headway in their negotiations, particularly with regard to the export side of the business.

Pig Iron.

This market is exhibiting a stronger tendency, and consumers appear to entertain fears that a scarcity of some brands of foundry iron may develop. The firmer position of the scrap market is also influencing the demand for pig iron, since some descriptions of scrap iron are in rather short supply and a tightness in this market will naturally lead to the heavier buying of pig iron. On the North-East Coast the demand for foundry iron has been catered for by only two furnaces, the difference between the supply and demand being met by withdrawals from stock. The quantities available for this purpose, however, are rapidly declining, and surprise is expressed that another furnace is not put into operation to meet the call for foundry iron. Another furnace, which it is reported will have a productive capacity of 2800 tons per week, is to be started shortly upon basic iron, but it is expected that later on this will be turned over to the production of foundry. The possibility that pig iron prices will be advanced has also been taken into account, since coke prices are rising and the ore position is not so easy as it has been for a long period. In the Midlands the position is not so firm, since consumption has not yet overtaken the demand. Anticipations that prices for Midland irons will be raised in some districts proved groundless, and at their meeting last week the long-standing figures were reaffirmed by the makers, who quote 62s. 6d. for Northamptonshire No. 3 and 66s. for Derbyshire No. 3 foundry and Lincolnshire and South Staffordshire iron, d/d Black Country stations and subject to rebate. There is a good demand for these irons, especially for Northamptonshire brands, the light castings makers in particular taking good quantities. Most of the big consumers, however, are covered up to the end of this year. Specifications against these contracts are well maintained, but current business consists chiefly of small parcels. In Lancashire the pig iron market has been rather less active than of late. The opening days of October, however, were characterised by a fair volume of buying, and it has yet to be seen whether this will be maintained during the remainder of this month. The engineering trades in Lancashire are not taking quite so much iron as a few weeks ago, but against this there seems to be rather more movement in the demand for iron from the textile machinery makers. In Scotland the market remains steady, both as regards prices and the amount of iron passing into consumption. Business with the light castings industry continues on a good scale.

Semi-finished Steel.

The demand for billets and sheet bars shows no signs of relaxing. For the time being, buying may not be so heavy as in the first part of the month, but there is a steady call against contracts, and this is supplemented by a considerable business in small parcels. As a result, the works producing this class of material in all parts of the country are busy. Competition from the Continent is scarcely heard of, and the prices quoted lately for foreign material have been so near to the British quotations that it has not been worth while ordering Continental material unless Thomas steel was specially required. Many producers are definitely asking £5 5s. for billets, although the official price is unaltered at £5 for 500-ton lots up to 0·25 per cent. carbon, whilst for smaller quantities up to £5 10s. has been quoted. Blooms over 7in. square do not come within the Association price arrangements, and the general quotation for this material is £5 to £5 2s. 6d. d/d. In the Sheffield district small quantities of Continental billets are said to be still available at around the British prices, but here there is an expectation that the latter will be advanced. Business in acid steel billets has not been active, but lately there has been some improvement in inquiry. The demand for carbon quality billets has become rather quieter, but on the whole the producers are well employed. Prices are unaltered, and range from £6 12s. 6d. for 0·42 per cent. to 0·60 per cent. carbon to £8 12s. 6d. for 1 per cent. carbon and up. The quotation for sheet bars also has become firmer, but the Welsh producers are holding their price for tin-plate and sheet bars at £4 15s. d/d. Continental offers of sheet bars, although occasionally made at cheap rates, have not affected this market for some time.

Scotland and the North.

One of the features of the Scottish steel trade is the good deliveries of plates against contracts already in existence. There has also been an improvement in the demand for shipbuilding steel generally, as conditions on the Clyde are better than for some time past, although the greater part of the business reaching the steel works has been from the ship repairing yards. The tube works in Scotland also appear to have passed through the quiet period of a week or two ago, and orders are now coming to hand with fair regularity. The re-rollers are experiencing a moderate demand for sections and hoops, but business with overseas markets is poor and the Scottish price has to be cut to obtain business in competition with English and Continental makers. In the Lancashire market trading has been rather listless lately, but most of the works are operating at a fair rate. It is not expected that the reaction will be of long duration; but, of course, in Lancashire much depends upon the conditions of the textile industry. Few orders for new textile machinery are being given out and some of the engineering firms are poorly off for work. In the lighter branches of the steel industry there seems to be a fair amount of business passing, the call for small bars for bright drawing purposes being particularly noticeable. Business in special alloy steels is expanding, although it has been on a good scale for some time past. The recent slight improvement in the demand for structural steel has been maintained; but some of the constructional engineers are approaching the time when they must obtain fresh orders or reduce their rate of operations. Busy conditions continue to prevail on the North West Coast. At Workington the mills have orders on their books for hoops and strip, and are expecting to remain well employed until the end of the year; operations at the rail mill have slackened. At Barrow the mills are engaged on rails, sleepers and semis.

The Copper Market.

More active conditions developed in the copper market this week, but this may be largely due to the buying which usually takes place at the beginning of the month, particularly when the month opens a new quarter. Concurrently with the better demand for electrolytic copper there was an improvement in business in manufactured copper materials, and some of the export merchants reported that overseas markets were showing more interest. In America the producers have retained their quotation of 9c., but most of the big American consumers appear to be well covered and new business has not been on a satisfactory scale. Considerable disappointment has been caused by the failure of the Russian order to mature. The Soviet Government evidently thought that the time was ripe to buy from the Americans on favourable terms, and commenced negotiations for the purchase of 100,000 tons. Had this deal gone through it would have been a considerable relief to the copper producers, who are holding stocks of over 600,000 tons. The Americans, however, would not agree to the Russian terms of credit, and when the American Government was approached to assist in financing the transaction it declined to help except under a guarantee of credit by the exporters of the copper. The whole matter, therefore, has been shelved for the time being. Russia is a producer of copper, but not on a sufficiently large scale for her needs, and requires to import about 30,000 tons per annum. The European demand has improved slightly, but is still much below normal. The standard market responded to the better conditions in the electrolytic market and prices have advanced over the week. It was generally considered that operators had discounted most of the unsatisfactory features of the position, so that the rise when the improvement occurred was not unexpected.

The Tin Position.

On the publication of the very favourable tin statistics at the end of September the market threw off the listlessness which had been affecting it for some weeks and prices rapidly advanced. The chief point in the statistics was the decrease in the visible supply, which, according to Mr. W. H. Gartsen's figures, was from 33,126 tons to 29,892 tons, a reduction of 3234 tons. The carry over in the Straits also fell by 1378 tons, but the carry over at the Arnheim Smelter in Holland increased by 517 tons, thus making a net decrease in the visible supply and the carry over of 4095 tons. Although these figures had been anticipated, they naturally had an encouraging effect upon the market and led to a revival of speculation, although this was not upon an important scale. American consumers also came into the market, but at the same time reports were current of re-sales in America. Continental buying, although it has improved to a certain extent, is still rather quiet. It is generally considered that the tin restriction scheme has been strengthened by the decision of the Cornish producers to become members of the International Tin Pool. It was announced that originally Cornwall had been offered a quota of 1500 tons, but following negotiations this had been increased to 2200 tons, which the producers had accepted as a reasonable figure. The demand for prompt tin has created a small backwardation, but there have been sufficient warrants circulating in the market to keep it at from 2s. 6d. to 5s. There is, of course, no scarcity of tin at the moment, although the steady reduction in the stocks and the shipments of tin to United States have given the impression that a stringency may develop later on. On the other hand, although it is not known how much tin has been sold by the Pool, it is evident that it controls a considerable tonnage.

Lead.

The position in this market has not materially changed. The consumptive demand for the raw metal remains quiet, although, as is usual, it improved in the early days of the month. The best feature of the market is the continued heavy call for manufactured lead materials, such as pipes and sheets, which are being produced and are passing into consumption in considerable quantities. The manufacturers covered their pig lead requirements in August for some time ahead, but it is probable that if the demand for their products continues on its present scale they will shortly be obliged to come into the market again. The position in the United States is shown by the August statistics to have improved to a marked extent. The stocks of refined lead at the end of the month totalled 160,486 tons, or 10,789 tons less than at the end of July. Production in August was 25,058 tons. The effect of the duties, however, is largely to neutralise this improvement so far as the British market is concerned, since it is adequately supplied by Empire producers, and lead coming from abroad is merely placed in bonded warehouses until it can be re-exported. Changes in the American position, therefore, have only a sentimental effect upon prices in this market. The producers seem quite content to follow the market and to supply consumers at current prices. This is regarded by the market as the most judicious course, and at the present low price of the metal should stimulate its use for industrial purposes. One effect of the low quotation is said to be that production is decreasing, but as it is known that considerable stocks exist in the hands of the producers, this has not yet had any influence upon prices.

Spelter.

For many weeks past spelter has been the steadiest of the non-ferrous metal markets, and this still remains its chief characteristic. Buying by consumers has not been active, but the galvanisers have shown rather more interest in the market. The demand from the brass manufacturers also has been quiet, and most of the works seem to have covered their requirements. A pronounced scarcity of hard spelter has developed, and consumers are relying upon the supplies produced in this country, as the duty payable upon imported hard spelter makes it almost as expensive as virgin metal. Hard spelter is used by the galvanisers in small proportions to obtain the "spangles" upon their sheets which are required by some overseas markets. The difficulties referred to last week, which it was thought might result in the dissolution of the International Zinc Cartel, were smoothed out at the meeting on September 30th in Brussels. The Belgian group had given notice of withdrawal from the Cartel owing to dissatisfaction at the way in which the fines on production in excess of the quotas were levied. Modifications were made to suit the Belgians, and it was unanimously decided to continue the Cartel. This is not the first time that this Cartel has been on the point of dissolution, but it is one of the most efficiently run organisations of this kind, and owes much of its success probably to its policy of regulating production and not interfering with prices. The announcement that the Cartel would be continued was well received by the market, and prices moved upwards. The conditions of the market, however, were not favourable to a sustained advance, although they were sound, and the movement was short-lived.

Average Metal Quotations.

The decline in the prices of metals disclosed by the London Metal Exchange average quotations for September follows a decrease recorded at the end of August. Previous to that month metal prices had for some time shown a strong tendency to rise. Tin is the only metal which has increased in value over the August average, and in this case the rise is £1 13s. 5d. for cash tin, and £1 13s. for three months. Copper prices have fallen to a greater extent than other non-ferrous metals, but, even so, the decrease is not heavy. Cash copper is down by 18s. 8d., and three months by 19s. 3d., compared with August, whilst the average price for electrolytic is lower by £1 18s. 9d., and for electrolytic wire bars by £1 19s. 6d. The steadiness of the lead market is shown by the fact that the average price of lead for shipment the current month is only 5s. lower than the August average, and for shipment the third following month and for the mean quotation the average is down 4s. 6d. and 4s. 9d. respectively. Spelter was even more steady, there being a decrease of only 1s. 2d. below the August average, whilst the average price for three months metal was 3d. above that of August. The average mean was 2s. 10d. down. The official average quotations for September are as follows :—

STANDARD COPPER	Cash	£35	3	7 3/16
	3 Months	£35	7	3 9/16
	Settlement	£35	3	8 3/16
ELECTROLYTIC COPPER		£38	13	10 5/16
ELECTROLYTIC WIRE BARS		£39	0	11 3/16
BEST SELECTED COPPER		£38	3	7 1/8
STANDARD TIN	Cash	£216	19	3 3/16
	3 Months	£216	18	4 5/16
	Settlement	£216	19	0 1/4
LEAD	For shipment the current month	£11	18	7 1/4
	For shipment the third following month	£12	4	7
	Mean	£12	1	7 3/4
	Settlement	£11	18	9 3/4
SPELTER	For shipment the current month	£16	16	2 3/4
	For shipment the third following month	£17	0	10
	Mean	£16	18	6 1/4
	Settlement	£16	16	6 1/4

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	2 19 6	2 19 6
No. 1	3 0 0	3 0 0
Cleveland—	*(D/d Tees-side Area.)*	
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
Midlands—		
Staffs.—	*(Delivered to Black Country Station.)*	
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ½in.	9 7 6	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ½in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ½in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL *(continued)*

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ½in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ½in.	9 7 6	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ½in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d.	10 0 0	9 0 0
21-G. to 24-G., d/d.	10 5 0	9 5 0
25-G. to 27-G., d/d.	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export; £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/9 to 17/-
Tin-plate bars, d/d South Wales works, £4 15s.

Billets.	£ s. d.
Basic Soft (25·41% C.)	5 15 0
„ Medium (0·42% to 0·60% C.)	6 12 6
„ Hard (0·61% to 0·85% C.)	7 2 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 25% C.), 500 tons and up	5 2 6
100 tons	5 10 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/- per lb.	
Ferro Tungsten	1/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 17 6	7/-
„ „ 6 p.c. to 8 p.c.	£19 7 6	7/-
„ „ 8 p.c. to 10 p.c.	£18 17 6	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£29 15 0	9/-
„ „ „ 1 p.c. carbon	£30 17 6	10/-
„ „ „ 0·70 p.c. carbon	£35 15 0	12/6
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£18 2 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, October 4th.

Copper—		
Cash	£34 17 6 to £35 0 0	
Three months	£35 2 6 to £35 3 9	
Electrolytic	£38 5 0 to £38 10 0	
Best Selected Ingots, d/d Birmingham	£38 15 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
Brass—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£221 15 0 to £222 0 0	
Three months	£221 15 0 to £221 17 6	
Lead:	£11 18 9 to £12 6 3	
Spelter:	£16 12 6 to £17 0 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

		Export.
Lanarkshire—		
(f.o.b. Grangemouth)—	Navigation Unscreened	12/6 to 13/-
„ Glasgow—	Ell	12/6 to 14/-
„ „	Splint	14/6
Ayrshire—		
(f.o.b. Ports)—	Steam	11/6 to 11/9
Fifeshire—		
(f.o.b. Methil or Burntisland)—	Steam	12/6 to 13/-
	Unscreened Navigation	12/- to 12/6
Lothians—		
(f.o.b. Leith)—	Hartley Prime	11/- to 12/-
	Secondary Steam	10/9 to 11/-

ENGLAND.

	Inland.	
Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/- to 19/6
Furnace Coke		13/- to 17/6
Northumberland—		
Best Steams		13/6 to 14/-
Second Steams		12/6 to 13/-
Steam Smalls		8/6
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/6
Foundry Coke		17/- to 18/-
Sheffield—	Inland.	
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	22/- to 24/-	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	8/- to 9/-	—
Nutty Slacks	7/- to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	17/9 to 18/6
Best Steam Smalls	13/6 to 14/-
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 26/-
Foundry Coke	19/- to 36/-
Furnace Coke	15/- to 17/6
Patent Fuel	21/-
Swansea—	
Anthracite Coals:	
Best Large	35/- to 38/6
Machine-made Cobbles	35/- to 48/6
Nuts	37/6 to 48/6
Beans	25/- to 30/-
Peas	18/- to 20/6
Rubbly Culm	10/- to 11/-
Steam Coals:	
Large	18/- to 20/6
Nuts	18/- to 25/-
Smalls	11/- to 13/-

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3¼d.
Diesel Oil	3¾d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Trade Arrangements.

Events are developing in a way that indicates a change in the French outlook on the economic situation so far as regards foreign trade. One authority has declared that the French Government made a disastrous mistake when it broke off commercial relations with Great Britain, meaning the imposition of the compensating tax of 15 per cent. at the time Britain went off the gold standard. It was declared that the tax represented only one-half of the subsequent currency depreciation, but it was really more with the various taxes that were added to it, and for certain classes of machinery that are ostensibly free of import duty, such as harvesting machinery, the charges amount to about 50 per cent. of the cost. The compensating tax was, moreover, regarded by British manufacturers as something in the way of a challenge, and as a distinct violation of commercial treaty obligations. The effect of that unfortunate retaliation on Great Britain for leaving gold has certainly been disastrous for French trade, in the sense that it has helped to divert channels of British trade elsewhere and to leave France a permanent loser of much of the business she transacted in what used to be her most important market. Another incident is the attitude of Germany towards the suppression of the import quotas under the system which gave *pro rata* allocations to countries enjoying the most-favoured-nation treatment. Germany derived more advantage from the system than any other country, and on the plea that France had violated the most-favoured-nation clause by utilising the quotas as a means of exchange, Germany was reported to have contemplated a denunciation of the existing commercial treaty with France. The French Government hastened to open negotiations for a revision of the 1927 treaty, so that there is some prospect of a settlement. As showing the situation of the four countries with which France does most business, the trade returns for the first eight months of the year reveal that Germany exported to France goods to the value of 2081 million francs, while the value of exports from France to Germany was 1061 millions. The figures for the United States were respectively 1093 million francs and 351 millions; Great Britain, 1513 millions and 1059 millions; and the Belgian-Luxemburg Union, 1340 million francs and 1411 millions. All the figures for this year have fallen heavily from those for 1932. The situation has become so serious that the plans to recover trade now being initiated by the French Government may be expected to hasten a resumption of negotiations with Great Britain.

Engineering Degrees.

The protest by the Fédération des Associations, Sociétés et Syndicats Français d'Ingénieurs against the Bill now before the Senate for the creation of a State engineering degree was followed by a correspondence, some of which appeared in translation in these columns. Monsieur Couturaud, one of the writers of those letters, has returned to the charge, and deals with the difficulties that have arisen out of the change over from one epoch of industrial activity to another, when the system of rationalisation created a new class of technicians who have swollen the ranks, and, it is affirmed, lowered the status of the profession. Ten years ago the Société des Ingénieurs Civils rejected proposals then made for the protection of engineers because the profession had been honoured by distinguished men who did not possess degrees. Manufacturers themselves had no settled ideas on the matter. Nevertheless, the idea of forming a corporative body of engineers was gaining ground when the Fédération des Associations, Sociétés et Syndicat Français d'Ingénieurs was constituted. The Federation should then have taken in hand the work of organising the profession and granting diplomas. As matters now are, Monsieur Couturaud affirms that the Bill before the Senate will favour an inflation of the engineering profession instead of a deflation. This must, he says, be avoided by taking measures to ensure that degrees will only be granted by schools into which candidates enter by examination; that the Conservatoire des Arts et Métiers will limit the number of diplomas to be granted each year, and that for the State degrees political interference shall not be allowed to influence the examining commission in any shape or form.

Steam and Oil Engine Traction.

During the past summer the State Railways ran a service of Bugatti rail motor coaches between the Paris Gare St. Lazare and Deauville, a distance of 137½ miles, in just under two hours. Last month the motor coaches were replaced by a transformed "Pacific" locomotive, similar to that running on the Paris–Orleans Railway, with Dabeg poppet valves. It hauled four coaches and a van, representing a load of 238 tons. Except for compulsory speed reductions and a slowing down on gradients, the train maintained the maximum permissible speed of 120 kiloms. (74½ miles) an hour, and with an average of 68·68 miles for the full distance, it accomplished the journey in about the same time as the rail motor coach.

The Steel Cartel.

At a meeting of the International Steel Union in Paris last week, the effect of the dollar and sterling fluctuations on the export trade was discussed, particularly with reference to the activity of United States steel producers in South America. The attitude of the Union in face of these currency fluctuations is uncertain. It is felt that any definite action will be paralysed until there is some stabilisation, when it is hoped that British steel makers may be induced to co-operate with Continental producers. Representatives from Austria, Hungary, and Czechoslovakia were present at the meeting with the idea of keeping in line with the Union. It is found difficult to adhere strictly to the method of applying quotas, and while Belgian and German steel makers have kept well within the quantities allotted to them for export the French have fully availed themselves of the liberty allowed to members to accept orders at low prices under certain competitive conditions.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

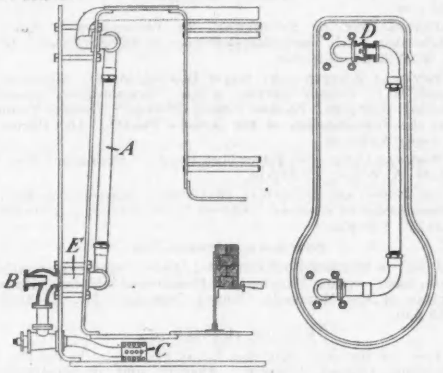
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

397,734. January 30th, 1933.—Circulators for Scotch Boilers, T. C. Nesbitt, 11, Milton-road, West Hartlepool.

In order to equalise the temperature at the top and the bottom of the boiler and thus minimise expansion stresses the inventor arranges a pipe A inside the combustion chamber and introduces the feed water through it. The feed is connected at B and produces an injector action. The inlet to the injector is connected with a strum C in the bottom of the boiler and a non-return valve is provided at D. Where the feed pipe passes through the back plate, at E, it may either be expanded in place or threaded through a larger tube.—*August 31st*, 1933.

Nº397,734

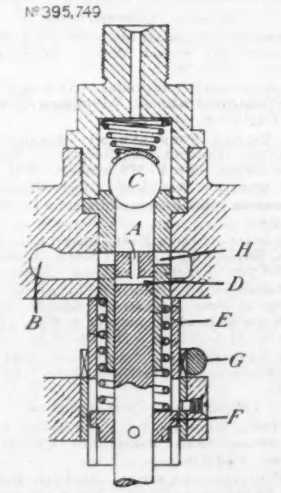


INTERNAL COMBUSTION ENGINES.

395,749. January 21st, 1932.—Fuel Injection Pumps, A. A. Sydney, 36, Chipstead-avenue, Thornton Heath, Surrey.

The working chamber A of this fuel pump is supplied with the oil inlet B and discharges through the loaded ball valve C. The plunger is drilled axially and transversely, as shown at D. The plunger is surrounded by the sleeve E, with which it is connected by the lugs F. The sleeve can be rotated by the rack and pinion G. The rack is connected with the governor, which, by bringing the ports D more or less into alignment with the ports H, bypasses some of the fuel according to the load on the engine.—*July 21st*, 1933.

Nº395,749



SWITCHGEAR.

397,335. November 1st, 1932.—Liquid-break Electric Switches, International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.

In accordance with this invention the aperture in the explosion chamber of a liquid-break switch through which the movable contact rod is adapted to pass is provided with a resilient annular packing similar in action to a stuffing-box in order to prevent the escape of liquid. The wall A of the aperture has a groove B for the reception of a metallic annular helical spring ring C, or, as shown on the right-hand section, a rubber annulus D sheathed with metal, so divided that it does not affect the elasticity of the rubber annulus. The helical spring ring C or the rubber annulus D closely surrounds the contact E. A certain amount of play is, however, provided in the groove B to allow for a lack of alignment of the contact rod.—*August 24th*, 1933.

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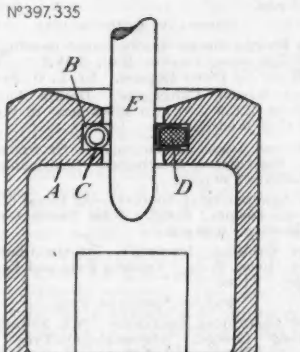

ELECTRICAL APPLIANCES.

397,105. November 12th, 1931.—Electric Cut-outs, Francis Thomas, of 33, St. Stephen's House, Westminster, S.W.1.

According to this invention, in combination with electric mercurial cut-outs, which by reason of their totally enclosed structure give no indication externally on breaking circuit, a neon or other luminous gas discharge tube A is provided, which serves both as an indicating device to show at a glance the continuous or the interrupted condition of the cut-out and as a surge-absorbing device. In a mercurial cut-out there is a tendency for the maintenance of a mercury arc which, for the proper functioning of the cut-out, it is essential to avoid, and it has been found that the provision of a gas discharge tube achieves this result by forming a by-pass so that a current surge through the cut-out itself and the maintenance of a mercury arc are eliminated. It will be seen, therefore, that the provision of a gas discharge tube in combination with a mercurial cut-out has, in addition to its indicating property, a function which is non-existent in the case of such a gas discharge tube in association with a cut-out of the fusible type. While, for the purpose of the invention, any suitable form of gas discharge tube may be used, it is preferred to employ a tube with external electrodes. Each electrode is therefore formed by a metallic coating on the tube, the coatings being separated by a space which is comparatively narrow, for example, in the neighbourhood of one-sixteenth of an inch. The separating space may be enlarged locally to form a window for the purpose of rendering the glow more distinct.—*August 14th*, 1933.

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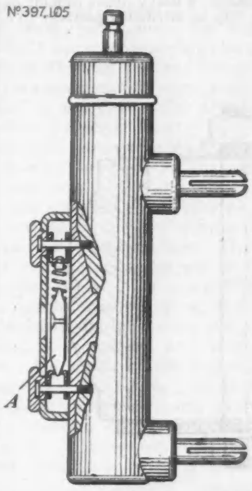

397,234. March 29th, 1932.—Electric Fusible Cut-outs, William Herbert Turner, of the Grove, Meanwood, Leeds; and William Herbert Isherwood, of 4, Caythorpe-road, Leeds.

The fusible cut-out described in this specification is particularly suitable for the protection of lines and apparatus operating at extra high pressure. The melting of the fuse wire A, whether due to overload or to breakdown, results in the formation of an arc between the two electrodes and through the liquid which is thus vaporised very rapidly and so fills the closed chamber with vapour, which in a very short period reaches a high pressure and causes the vessel B to burst or to give rise to failure of the joints. This allows sudden and almost unhindered expansion and cooling of the vapour surrounding the arc to occur. De-ionisation of the electric field between the electrodes is so rapid that re-establishment of the arc after extinction at zero point of the current curve is prevented.—*August 24th*, 1933.

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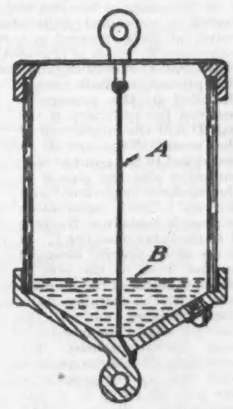

TRANSMISSION OF POWER.

397,384. February 10th, 1933.—Friction Clutches, A. Anderton, of W. R. Anderton and Co., Railway Ironworks, Castleton, Rochdale.

This invention relates to friction clutches of the plate type, in which one or more friction plates secured to one member of the clutch are gripped between plates secured to the other member. A is the outer portion free to revolve on the shaft or keyed to the driving shaft when used as clutch coupling. B is the friction plate fitted with fibre facings, and is a sliding fit in the outer portion A and secured to it radially by pins C. The inner portion D is keyed to the shaft E and is provided with a flange at one end, forming a friction plate, the other end being screwed to receive a collared adjustable bush F. G is a sliding

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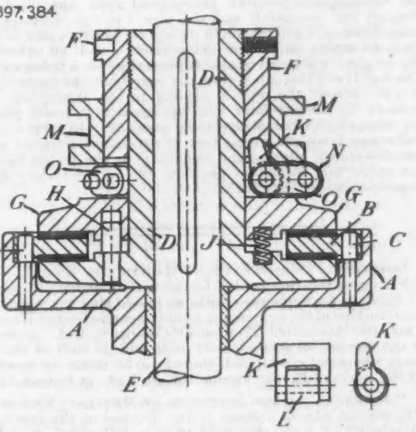
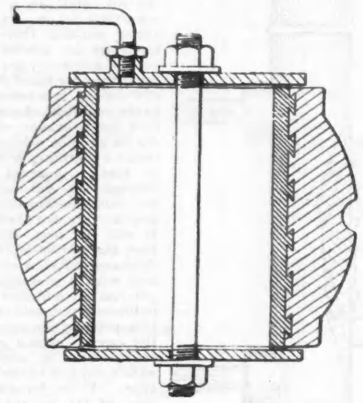


friction plate mounted on the inner portion D and is secured by pins H so as to allow axial movement only. Springs J may be fitted between the friction plates. A number of toggle levers K are fitted between the plate G and the bush F radially arranged round the inner portion D; each of these toggle levers is provided with a jaw at one end to receive the roller L; the opposite end is arranged to pivot in the end face of the collared bush F. M is a sliding sleeve mounted on the collared bush F provided with lugs N and is connected to the toggle levers K by levers O fitted on each side of the lugs and toggle levers. To operate the clutch, the sliding sleeve M is moved towards the friction plates, which alters the inclination of levers O, causing the jawed ends of the toggle levers K to be forced inwards towards the shaft, and the rollers to press against the friction plate G, giving the desired grip.—*August 24th*, 1933.

395,890. March 3rd, 1932.—Bearing Brasses, *P. W. Gray. The Sperry Gyroscope Company, Ltd., Great West-road, Brentford, Middlesex.*

It is suggested that the vibration of heavy rotors running at high speeds on vertical shafts may be attributed partially to a lack of cohesion between the white metal of the bearing and its carcase. The inventors propose to overcome this trouble by expanding the white metal, after it has been cast in place, by hydraulic pressure. The illustration needs no comment.—*July 27th*, 1933.

No 395,890



MISCELLANEOUS.

397,439. May 5th, 1933.—Fluid Pressure Regulators, Schweizerische, Lokomotiv und Maschinenfabrik, Winterthur, Switzerland.

This invention relates to an auxiliary control valve for pressure regulators in which the control valve actuates a regulator valve as soon as a predetermined maximum pressure and predetermined minimum pressure are attained. In the drawing A is the casing or housing and B the control piston, which is loaded by a weight C adjustable in any desired manner. The valve ball D is arranged in a recess N of the interchangeable valve seat E, which is provided with a bore F. The diameter of the ball D is only slightly less than that of the recess N, so that pressure medium (air) is throttled in the passage G between the periphery of the ball D and the lateral wall of the recess. The pipe H is connected to the point of consumption and the pipe J to the regulator or governor (not shown). The equalisation channel K leads from the pipe J to the lower chamber L. M is the outlet opening arranged at the level of the pipe J, which establishes communication with a chamber at a lower pressure, and in the example shown communicates with the atmosphere. The operation of the control is such that on the pressure in the pipe H rising to a predetermined degree which corresponds to the load C on the control piston B the ball D, pressed by the latter against its seat, and therefore the piston B will be raised. The throttling passage G ensures that the consumption pressure acting on the whole surface of the lower half of the ball will rapidly raise the piston to its highest position. The connecting pipe M will be now closed by the piston B, and the consumption pressure transmitted from the chamber L through the channel K and the pipe J to the regulator. The control piston B will remain in its highest position only until the pressure acting on it from below falls to such an extent that the weight C will again be able to press the piston B downwardly. The ball D will thereupon close the bore F and the control piston B will uncover the pipe M leading to the atmosphere. The pressure in the regulator will fall again to a lower pressure, for example, to the atmospheric pressure. By replacing the valve seat E by one with a bore of a different diameter and by simultaneously altering the weights C or the piston load, the maximum and minimum pressure can be set to any desired degree.—*August 24th*, 1933.

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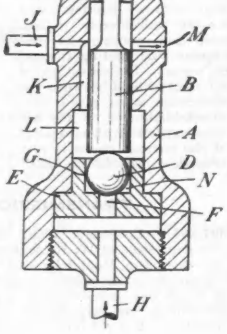

Correction—Brooke-A.E.C. Marine Oil Engine.—When referring to the Brooke-A.E.C. marine oil engine, on page 265 of our issue for September 15th, we stated that the whole of the construction of the new engine would be carried out at Lowestoft. This, the Associated Equipment Company, Ltd., informs us, is not correct, as all the power units will be built at that company's Southall works, and altered to fit them for marine use at the works of Brooke Marine Motors, Ltd., at Lowestoft.

"Journal" of the Institute of Metals: Volume L.—The second annual volume of the *Journal* of the Institute of Metals, which is devoted entirely to metallurgical abstracts, as distinct from original papers, has just appeared. It is entitled "Metallurgical Abstracts and Index," and contains 962 pages, of which the index covers 177 pages, and has 20,000 entries. The price with two volumes of "Proceedings" is £4. It is claimed to contain concise summaries of everything of a metallurgical character that has recently appeared in the world's technical literature.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day.

Inst. of Chemical Engineers.—In Rooms of Chemical Soc., Burlington House, W.1. "The Sedimentation of Fine Particles in Liquids: A Survey of Theory and Practice," Mr. R. F. Stewart and Dr. E. J. Roberts. 6 p.m.

Institution of Sanitary Engineers.—Caxton House (Hill's Restaurant), Tothill-street, Westminster, S.W.1. Opening sessional meeting. Reception, 7.30 p.m.; music and dancing, 8 p.m. until 11.30 p.m.

Inst. of Production Engineers: London Section.—At Council Room, Soc. of Motor Manufacturers and Traders, 83, Pall Mall, S.W.1. "Jig and Tool Design," Mr. E. J. H. Jones. 7.30 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Education with Particular Reference to the Engineer," Mr. K. W. Willans. 7.30 p.m.

Physical Society.—At Royal Institution, 21, Albemarle-street, W.1. Council meeting, 4 p.m.; extraordinary general meeting, 5.30 p.m. Thomas Young Oration, "Thomas Young and the Simplification of the Artist's Palette," Dr. Herbert E. Ives. 5.45 p.m.

Railway Club.—57, Fetter-lane, E.C.4. "Permanent Way," Mr. W. A. Willox. 7.30 p.m.

Sir John Cass Technical Institute.—Inaugural meeting. Presentations to students. Address by Sir Robert A. Johnson, K.B.E. 8.15 p.m.

Saturday, October 7th.

Inst. of British Foundrymen: Lancashire.—Engineers' Club, Albert-square, Manchester. Presidential address, "Manufacture of the Mammoth Cunard Castings," Mr. F. Swift. 3.45 p.m.

Monday, October 9th.

Inst. of Metals: Scottish Local Section.—At the Royal Technical College, Glasgow. Display and demonstration, arranged by Professor Robert Hay, B.Sc., Ph.D. (Chairman).

Inst. of Production Engineers.—In the College of Technology, Manchester. "The Growth of the Big Industrial Corporation," Mr. W. L. Hichens. 7.30 p.m.

Iron and Steel Inst.—Royal Metal Exchange, Swansea. "Fifth Report of the Committee on Heterogeneity of Steel Ingots," "Effect of Tin as an Impurity in Mild Steel," Mr. J. H. Andrew and Mr. J. B. Pfeile; "Factors Leading to Greater Production from a Steel Furnace," Mr. A. Robinson. 7 p.m.

Soc. of Chemical Industry.—In the Chemical Society's Rooms, Burlington House, W.1. "Tung Oil: Chemical Studies and Specifications," Dr. L. A. Jordan, and "Application of Fumigants to Warehouses," Dr. A. B. Page. 8 p.m.

Tuesday, October 10th.

Illuminating Engineering Soc.—At the Lighting Service Bureau, 2, Savoy-hill, Strand, W.C.2. Presidential address, Mr. C. W. Sully. 6.30 p.m.

Inst. of Automobile Engineers.—At King's Head Hotel, Coventry. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of British Foundrymen: Burnley Section.—Municipal College, Ormerod-road, Burnley. "Foundry Essentials and Incidentals," Mr. F. Whitehouse. 7.15 p.m.

Inst. of Metals: Swansea Local Section.—At the Y.M.C.A., Swansea. Chairman's address, by Dr. A. G. Ramsay, B.Sc. 6.15 p.m.

Inst. of Metals: North-East Coast Local Section.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Exhibition of films. 7.30 p.m.

Inst. of Petroleum Technologists.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C.2. "The Modern High-speed Diesel Engine and its Place in Road Transport," Major W. H. Goddard, A.M.I. Mech. E. 5.30 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Properties of Austenitic Steels," Dr. L. B. Pfeil. 7.30 p.m.

Wednesday, October 11th.

Inst. of Civil Engineers: Manchester and District Assoc.—36, George-street, Manchester. Chairman's address, Mr. A. C. Dean. 6.45 p.m.

Inst. of Engineers-in-Charge.—St. Bride Institute, Bride-lane, E.C.4. Presidential address, "The E.I.C. and his Need for Administrative Ability," Lieut.-Col. J. D. K. Restler, O.B.E. 7.30 p.m.

Inst. of Fuel.—In the Lecture Hall of the Geological Soc. of London, Burlington House, Piccadilly, W.1. The Melchett Lecture, "The Place of Oil in the World of Fuel," Sir John Cadman. 5.30 p.m.

Newcomen Soc. for the Study of the History of Engineering and Technology.—In the Hall of the Chartered Inst. of Patent Agents, Staple Inn-buildings, London, W.C.1. Mr. H. W. Dickinson, M.I. Mech. E., will deliver his presidential address at 5.30 p.m.

Television Soc.—At University College, Gower-street, W.C.1. "Television at the 1933 Berlin Radio Exhibition," Mr. E. H. Traub. 7 p.m.

Thursday, October 12th.

Diesel Engine Users Assoc.—Joint meeting with Inst. of Chemical Engineers, Caxton Hall, S.W.1. "Treatment of Cooling Water for Diesel Engines," Mr. L. O. Newton. 3 p.m.

Inst. of Marine Engineers: Junior Section.—85–88, The Minories, E.C.3., "'Two Milestones' in Workshop Practice," Mr. G. J. Wells. 7 p.m.

Manchester Assoc. of Engineers: Students' Section.—Y.M.C.A., Peter-street, Manchester. Chairman's address, Mr. Frank Walker. 7.30 p.m.

Royal Aeronautical Society.—At Royal Society of Arts, John-street, Adelphi, W.C.2. "Air Traffic Control," Major R. H. S. Mealing. 6.30 p.m.

Soc. of Chemical Industry.—At the Chemical Society, Burlington House, W.1. "Canning Fruit and Vegetables," Mr. G. Cadbury. 8 p.m.

Friday, October 13th.

Inst. of Electrical Engineers: N.E. Students' Section.—Armstrong College, Newcastle-upon-Tyne. Chairman's address, "The Rating and Performance of Circuit Breakers," Mr. R. W. L. Harris. 7.15 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—Grosvenor Restaurant, Glasgow. "James Watt" dinner.

Inst. of Metals: Sheffield Local Section.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Centrifugal Casting of Non-ferrous Alloys," Mr. F. W. Rowe, B.Sc. 7.30 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "The Influence of Harmonics in Transformer Circuits," Mr. Ernest Ambrose, M.I.E.E. 7.30 p.m.

Manchester Assoc. of Engineers.—Engineers' Club, Manchester. Presentation of Medals. Presidential address, Dr. T. B. Morley. Smoking concert. 7.15 p.m.

Saturday, October 14th.

Inst. of Marine Engineers: Junior Section.—85–88, The Minories, E.C.3. Social and dance. 7.30 to 11.15 p.m.

Monday, October 16th.

Bradford Engineering Soc.—Joint meeting with the Technical College, at the Technical College, Bradford. "Degreasing of Metals," Mr. H. O. Brown. 7.30 p.m.

Tuesday, October 17th.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. "Oil from Coal," Dr. W. R. Ormandy and Dr. J. Burns. 6 p.m.

Sheffield Metallurgical Soc.—198, West-street, Sheffield. "Exhaust Valve Failures," Mr. C. C. Hodgson. 7.30 p.m.

Wednesday, October 18th.

Inst. of Fuel.—In the Lecture Hall of the Geological Soc. of London, Burlington House, Piccadilly, W.1. Presidential address by Sir Wm. J. Larke. 11.30 a.m.

Inst. of Fuel.—At Geological Society's Rooms, Burlington House, W.1. "Recent Developments in Coking Practice," Dr.-Ing. H. Koppers. 2.30 p.m.

Inst. of Fuel.—Connaught Rooms, Great Queen-street, W.C.2. Annual dinner and dance. Presentation of the Melchett Medal to Sir John Cadman. 6.45 for 7.15 p.m.

Friday, October 20th.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting; election of Sub-committee. 7 p.m.

Inst. of Sanitary Engineers.—At Caxton Hall, Westminster, S.W.1. "Aggregates for Concrete Work," Dr. Bernard H. Knight. 6 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "Air Lift Pumps," Mr. A. C. Judd (member). 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. Annual general meeting. Address by the President, Mr. R. J. Walker; cinematograph film, "Mechanism of Ships' Wake," Professor T. B. Abell.

Saturday, October 21st.

Inst. of Electrical Engineers: N.E. Students' Section.—Visit to Messrs. A. Reyrolle and Co.'s short-circuit test plant, Hebburn. 2.30 p.m.

Inst. of Mechanical Engineers: Graduates.—Visit to the de Havilland Aircraft Company, Stag-lane Aerodrome, Edgware.

Tuesday, October 24th.

Inst. of Automobile Engineers.—At Hotel Victoria, Wolverhampton. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow, C.2. "Flame Cutting of Steel for Welded Joints," Mr. E. J. Clarke. 7.30 p.m.

Sheffield Metallurgical Soc.—198, West-street, Sheffield. "Our Knowledge of the Conditions in the Blast-furnace," Mr. R. C. Tucker. 7.30 p.m.

Wednesday, October 25th.

Inst. of Mechanical Engineers: Yorkshire.—Grand Hotel, Sheffield. "Fatigue and Corrosion Fatigue, with Special Reference to Service Breakages," Prof. Frederic Bacon. 7.30 p.m.

Thursday, October 26th.

Glasgow University Engineering Soc.—At James Watt Engineering Laboratories, University. Presidential address by Mr. H. A. Reincke. 7.30 p.m.

Inst. of Electrical Engineers.—Savoy-place, W.C.2. Presidential address, Mr. P. V. Hunter. 6 p.m.

Inst. of Mechanical Engineers.—At Dorchester Hotel, Park-lane, W.1. Annual dinner, 6.45 for 7.15 p.m.

Inst. of Mechanical Engineers: Yorkshire.—Queen's Hotel, Leeds. "Fatigue and Corrosion Fatigue, with Special Reference to Service Breakages," Prof. Frederic Bacon. 7.30 p.m.

Midland Metallurgical Societies.—In the James Watt Memorial Inst., Gt. Charles-street, Birmingham. Discussion, "The Production of Sound Cast Iron Castings." 7 p.m.

Friday, October 27th.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. General meeting. Presidential address, Mr. Alan E. L. Chorlton. 6 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "The Electrolytic Theory of Corrosion," Mr. H. E. Yerbury, M. Inst. C.E., M.I. Mech. E., M.I.E.E. 7.30 p.m.

Saturday, October 28th.

Stephenson Locomotive Society.—Visit to Stratford, L.N.E. Railway Running Sheds. 2.30 p.m.

Monday, October 30th.

Bradford Engineering Soc.—Technical College, Bradford. "Salvage Work on the Ex-German Fleet at Scapa Flow," Mr. E. F. Cox. 7.30 p.m.

Inst. of Automobile Engineers.—At 39, Elmbank-crescent, Glasgow. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Stainless Steels," Mr. F. J. Murdoch. 6.45 p.m.

Tuesday, October 31st.

Inst. of Transport.—15, Savoy-street, W.C.2. Discussion, "The Duties of a Modern Transport Manager," Mr. M. F. Barnard.

LAUNCHES AND TRIAL TRIPS.

Steel Barges (three); built by Richard Dunston, Ltd., to the order of London owners; launch, September 26th.

Pass of Balmaha, oil tanker; built by Blythswood Shipbuilding Company, Ltd., to the order of Bulk Oil Steamship Company, Ltd.; dimensions, 200ft. by 30ft. 6in.; to carry oil in bulk. Engines, triple-expansion, 15in. by 25½in. by 41in. by 30in. stroke, pressure 190 lb. per square inch; constructed by David Rowan and Co., Ltd.; trial trip, September 27th.

University College Dinner.—A dinner to celebrate the fiftieth anniversary of the founding of the Engineering Society of University College, London, by Sir Alexander Kennedy, will be held in the College refectory on Thursday evening, November 16th, with Mr. Roger T. Smith in the chair. Tickets, 8s. 6d. each, may be obtained from Professor W. C. Clinton at the College.

A Seven-Day Journal

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Testimonial to Sir Henry Lyons.

To mark the retirement of Sir Henry Lyons, F.R.S., from the position of Director of the Science Museum, South Kensington, a presentation was made to him in the Science Museum on Wednesday morning, October 11th. Sir Richard Glazebrook, F.R.S., presided at the gathering in the Lecture Theatre, and among those present were Lord Irwin (President of the Board of Education), Sir Henry Pelham (Secretary to the Board of Education), Lord Rayleigh, F.R.S., Lady Lyons, and a large number of friends and colleagues of Sir Henry Lyons. Before the presentation and reading of an address to Sir Henry, signed by all the members of the Advisory Council of the Museum—who also were responsible for the gift of a handsome mahogany writing table—Sir Richard spoke of the manner in which the Science Museum has developed under the direction of Sir Henry Lyons, and at the same time he read several letters from prominent men, expressing appreciation of his work and suggesting, as a mark of the work of Sir Henry, that a new central block should be started at an early date. The address presented to Sir Henry Lyons expressed the regret of all the members of the Advisory Council of the Science Museum at his retirement, and their great appreciation and admiration of the work he had done. It recalled that when, in 1920, Sir Henry was appointed, the Museum was a small institution known only to a few. The eastern block, planned in pre-war days by Sir Hugh Bell's Committee, was incomplete. The collections, scattered throughout various unsuitable buildings, were without order and arrangement. By his tact, energy, and ability, however, Sir Henry had made the Museum what it now is and was known to be—a treasure house of past achievements and an inspiring guide to future progress. One single fact sufficed to indicate the magnitude and success of his work: the number of visitors had increased from about 400,000 in 1921 to nearly 1¼ millions in 1932. Lord Irwin made the presentation, and Sir Henry Lyons, expressing his thanks for what had been said of his services and for the gift, at the same time spoke of his gratitude to the Board of Education for encouraging him to develop the idea of a modern technical museum. At present there were only two in existence—the Science Museum, South Kensington, and one in Germany—but twelve others were being developed in other countries. The wisdom of that work was seen in the increasing number of persons visiting the Science Museum.

Industrial Uses of Gas.

In the course of a paper read at the Scottish Conference of the British Commercial Gas Association, which took place at Dunfermline last week, Mr. J. W. M'Lusky, the general manager of the Glasgow Corporation Gas Department, dealt with the development of the industrial field. There was no doubt, he said, that the 18,000,000 tons of coal purchased annually by the gas undertakings of the British Isles could be very largely augmented if the advantages of gaseous fuel were brought home to industrialists. In addition to the basic industries, there were many special industries in which gas was being widely used. In the Glasgow area recent developments in the industrial field had, for instance, been more pronounced in the baking trade than in the engineering and allied industries. With regard to conversions from oil to gas, the general attitude was very favourable towards gas, but with the proposed oil-from-coal schemes many manufacturers using oil were prepared to await future developments. A few instances in which gas had been used, and was being formally considered in preference to oil, included, he said, oven furnaces for spring-making and heat treatment in a railway engineering works; gas-fired boilers for varnish manufacture, and furnaces for melting brass and type metal.

Two Important Motor Ship Launches.

Two important launches of motor ships have recently taken place, one on the Tyne and the other in Belfast. The Tyne-built ship is the "Port Chalmers," which has been constructed by Swan, Hunter and Wigham Richardson, Ltd., at the firm's Wallsend yard, for the service of the Commonwealth and Dominion Line, Ltd., of London. The ship, which was launched on Tuesday, October 3rd, has a length of 486ft. 6in., a beam of 65ft. 3in., and a measurement of about 8800 gross tons. Here deadweight carrying capacity is close upon 11,500 tons. A feature of her hull construction has been a free use of welding instead of riveting in many parts of the structure. Although she will carry about twelve passengers, the new ship is mainly designed for the carriage of perishable goods, such as meat, fruit, and dairy products, and no less than 46,500 cubic feet of insulated space is provided in her holds and 'tween deck spaces. The refrigerating equipment has been designed by J. and E. Hall, Ltd., of Dartford, and includes special refrigerating and ventilation arrangements. The propelling machinery consists of a twin-screw arrangement of Barclay Curle-Doxford opposed-piston engines, designed to give the ship a speed of about 15½ knots when running at 96 r.p.m. The auxiliary machinery equipment is electrically operated for the most part. The Belfast launch, which took place on Monday last, October 9th, from the yard of Workman Clark (1928), Ltd., was that of the motor liner "Isipingo," one of three now being built for the mail and cargo services of Andrew Weir and Co., Ltd., of London, between Indian and South African ports. The new ship has an overall length of 425ft., a breadth moulded of 57ft., and a depth of 37ft. She will carry a full complement of first, second, and third-class passengers, as well as general and refrigerated cargoes. The propelling machinery, constructed in the builders' shop, consists of two sets of Workman Clark-Sulzer engines, designed to give the vessel a speed of 15 knots.

Statistics in Industry.

The Council of the Royal Statistical Society has decided to form a section for the purpose of promoting the application of methods of statistical analysis to problems in industry and agriculture. In the last decade or so there have been considerable developments in the application of modern statistical methods to technical problems met with in industry and agriculture. In the opinion of the Council the time is now ripe for the formal provision of facilities which will give a common platform for discussion to those who have problems to solve requiring the use of these methods. There are, on the one hand, special research problems involving careful planning and experiment, such as occur from time to time at an agricultural research institution, or in the research department of a large industrial firm. There are also many problems that arise in the course of routine production and exchange; problems of sampling and testing; questions as to whether measurements taken are used to best advantage; how far they are adequate for the purpose intended, and to what extent some of them may even be redundant. The facilities provided by the section will be two-fold—(1) the holding of regular meetings, and (2) the publication of a Supplement to the *Journal* of the Royal Statistical Society which will be devoted entirely to the study of this aspect of statistical science. The first meeting will be held on Thursday evening, November 23rd next, at the Hall of the Royal Society of Arts, John-street, Adelphi, at 5.30 p.m.

The Metropolitan Water Board.

At a meeting of the Metropolitan Water Board, held on Friday last, October 6th, Lieut.-Colonel J. R. Davidson, chief engineer to the Liverpool Corporation waterworks, who, on attaining the age of sixty on May 30th, 1934, will retire on pension, was appointed chief engineer to the Board at a salary of £5000. It was pointed out by the General Purposes Committee that important matters requiring early consideration, with regard to the adequacy of the Board's works to meet future requirements, were now pending. These included questions of additional storage, improved means of distribution, intercommunication, and the modernisation of the pumping machinery. While the Committee had every confidence in the deputy chief engineer, recently appointed, it considered it desirable to secure for a limited period the services of a water engineer of the highest distinction and experience. Mr. F. G. Howard, the Chairman of the Committee, said that while it was the policy of the Board to promote from within its own staff, their own engineers lacked the long and varied experience which the position demanded. The work in prospect would involve an expenditure of possibly £4,000,000, and if the Board was to engage consultants the fees payable would be £100,000. There was some opposition to the proposal of the Committee, but Lieut.-Colonel Davidson was appointed by 31 votes to 5. At the same meeting it was reported that Sir Alexander Houston, Director of Water Examinations, had tendered to the Board his resignation as from the end of the present year. In accepting the resignation the Board placed on record its high appreciation of Sir Alexander Houston's services during the past twenty-eight years.

A Clydebank Naval Order.

The Admiralty announces that the contract for building the convoy sloop H.M.S. "Bittern," has been placed with John Brown and Co., Ltd., of Clydebank. The new vessel, we understand, will have a normal displacement of about 1500 tons, and will provide employment for hundreds of men over a period of about eighteen months. The new order brings the number of naval vessels now under construction at Clydebank to five. In February last the firm received orders for two "Fearless" class destroyers, while work is also well advanced on the two mine-sweeper sloops "Skipjack" and "Halcyon," which were ordered in September, 1932. Six of the eight building berths at Clydebank are now occupied, the largest being taken by the unfinished new Cunarder. The sloop order above mentioned is the only naval vessel of the 1933 programme to be proceeded with this year. The Admiralty 1933 programme includes four cruisers, a flotilla leader, eight destroyers, three submarines, and four sloops, in addition to the one just ordered, besides other small craft. Most of these ships are to be built in private yards, and the contracts will, it is expected, be given out about February or March next year.

Steel Trade Improvement.

In a speech on Tuesday, October 3rd, following his installation as Master of the Cutlers' Company of Hallamshire, Mr. J. C. Walsh referred to the definite improvement in the steel trade which had taken place since the beginning of the year. Sheffield was now producing, he said, a greater tonnage of steel than in pre-war times, and something like 27,000 tons a month more than in the corresponding period of last year. The average monthly output of steel for the whole country over the first eight months of the year was more than 99,000 tons greater than the monthly average for the whole of 1932, and with the addition of several large new furnaces which had been started up in various parts of the country, the output would be substantially increased. Mr. Walsh was of the opinion that some share of the improvement must be attributed to the tariffs on imported steels. The newer Sheffield products, such as magnets, razor blades, and stainless steels, had made great strides during the year, and there was a likelihood of further developments in these special lines. He spoke of the larger passenger and goods returns on the railways, as an evidence of Britain's increasing prosperity, and expressed the hope that the companies would soon resume their normal programmes of renewals, for railway materials were largely supplied by Sheffield manufacturers. Mr. J. C. Walsh is a general manager of the United Steel Companies, Ltd., and he succeeds Colonel A. N. Lee in the office of Master Cutler.

Improved Unemployment Figures.

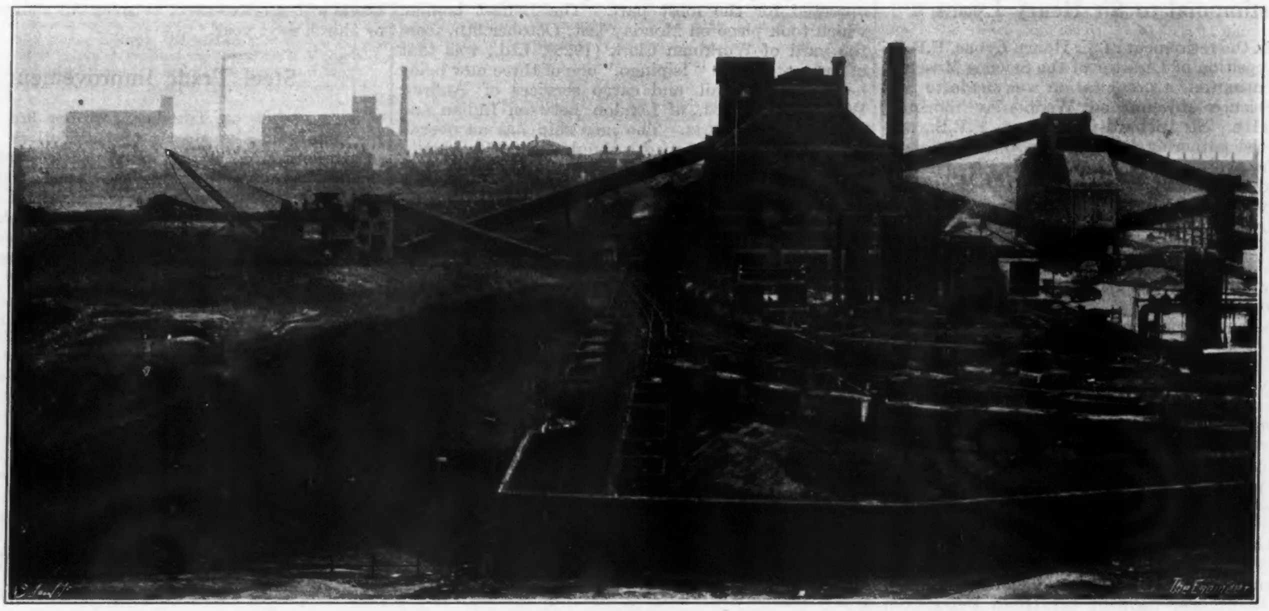
According to a statement issued by the Ministry of Labour early in the week, the figures for September 25th, 1933, show a marked decrease in the number of unemployed persons. There were 74,410 less unemployed than in the preceding month and 521,284 less than a year ago, the present figure having brought down the number of unemployed to 2,336,727. With regard to the employment of insured persons, last month's returns show an increase of 86,000 for the month, or 792,000 more than a year ago, which bring the number of employed up to 9,943,000. It is pointed out that the figures for each month of the present year, with the exception of July, in which there was an increase of 4000, have indicated a steady decrease in the number of unemployed persons, the total being well over half a million less than at the end of January last. Among the industries which show the largest increase in employment during the January–September period, is coal-mining, which now has 46,000 fewer unemployed, mainly in the Midland, Yorkshire and North-Eastern areas. The reduction of unemployment in other industries is indicated by the figures given below:—Iron and steel, 8000; general and electrical engineering, 5000; motor car manufacture, 6000; metal goods manufacture, 8000; pottery, 7000; cotton, 11,700; wool, 5500; hosiery, 2000; jute, 1200; and boot and shoe, nearly 4000. These eleven important industrial groups show together a total decrease of over 104,000 unemployed. The unemployed figures for Germany were also better last month.

Bridge Replacement at Neasden.

A remarkable engineering feat was successfully accomplished at Neasden on Sunday, last, October 8th, when a 60-ton bridge carrying the Cricklewood–Acton branch line of the L.M.S. Railway over Neasden-lane, N.W., was dismantled and replaced by a new structure weighing 160 tons in a single day. The new bridge, which has been provided in order to permit of the working of heavier locomotives over this section of the L.M.S. line, had been erected beforehand on trestling above the roadway. Operations began early on Sunday morning with the arrival of a 36-ton steam crane from the L.M.S. depôt at Kentish Town, N.W., together with a train of wagons and other equipment in charge of expert engineers and some 100 railway and other workmen. The old bridge was rapidly demolished, the girders, flooring, and other parts of the structure being lifted out of position by the steam crane, which loaded the material into rail wagons for removal, while a gang of men with compressed air drills cut up the stone abutment of the old bridge. Shortly after 4 p.m., before the last pieces of the old structure had been removed, work was begun on moving the new bridge into position, this being performed by four men winding on winches, whereby the complete bridge was moved on ball bearings along the trestling into its place. By Sunday night the complete bridge was in position and tracks laid over it in time for the passage of the first train on Monday morning, the work being completed well within scheduled time.

HIGGINSHAW GASWORKS OF THE OLDHAM CORPORATION

MR. F. GREENHALGH, BOROUGH GAS ENGINEER, DESIGNER



Oldham Gasworks.

THE new gasworks of the Oldham Corporation are probably the most modern and elaborately equipped of their kind in the country, for they have not yet been in operation for six months. They have been erected in consequence of the steadily increasing local demand for gas, and on account of the fact that there was only a margin, with the old plant, of 6 per cent. between the maximum daily demand and output. There were, of course, the gasholders to fall back upon in case of emergency. The new works have been constructed to the designs of Mr. F. Greenhalgh, the Borough Gas Engineer, and are illustrated by the accompanying drawings and engravings.

Previous to the alterations the Borough possessed three gasworks: one, known as the Central, equipped with Dempster-Toogood continuous vertical retorts capable of producing 1,000,000 cubic feet of gas a day; another, at Hollinwood, with Glover-West continuous vertical retorts making 3,000,000ft. a day, with a subsidiary water-gas plant of 1,500,000ft.; and the Higginshaw works. It is the latter which have been remodelled. They were originally equipped with horizontal retorts, capable of producing 2,750,000 cubic feet of gas a day, which were about thirty years old.

The Higginshaw site is well in the centre of the district to be supplied and has an area of 33 acres of made ground. It has a connection with the L.M.S. Railway and siding accommodation for 120 wagons. The old buildings, which are indicated by dot and dash lines on the map on page 349, have been entirely demolished and in their place the new gas-making plant housed. The relative sizes of the old and the new plants and how space has been saved by the adoption of modern carbonising plant in the place of the old horizontal retorts will be appreciated. The new plant is capable of producing 4,500,000 cubic feet of gas a day, or nearly twice as much as the old, while it occupies much less space. It is intended to carbonise 234 tons of coal a day.

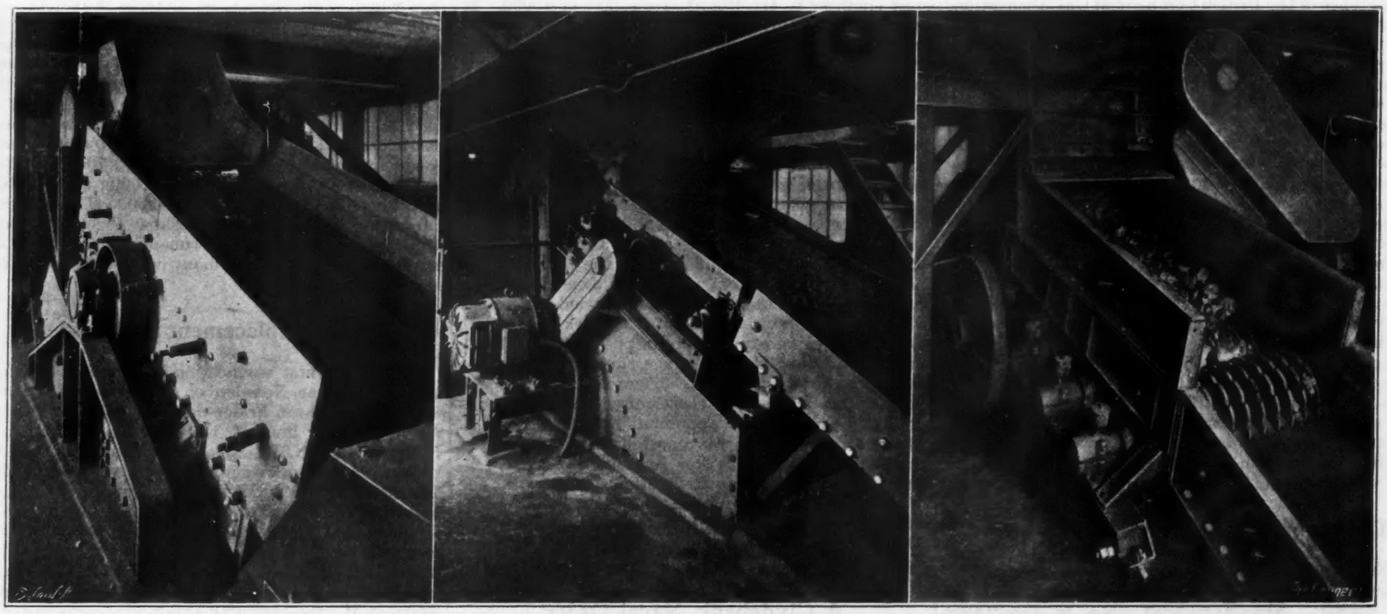
The essential features of the new works comprise an entirely new carbonising plant with vertical retorts, an extensive system of conveyors and cranes for handling the raw coal and coke, a plant for classifying and dispatching the coke, and by-product recovery apparatus, together with all their ancillary services. As will be seen from the plan, the raw coal comes in on one side of the site, is carbonised at the centre, and leaves, as gas and coke, on the opposite side. Incidentally, the "lay-out" has been so arranged that extensions can be conveniently carried out.

The Carbonising Plant.

The carbonising plant, which was supplied by the Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd., of 136, Victoria-street, Westminster, comprises a group of twenty-eight vertical retorts arranged in two rows of fourteen back to back, with the producers necessary for supplying the heating gas on one side of the row and the boilers used for conserving the otherwise waste heat on the other side. The arrangement of the various units is well illustrated by our drawings on page 351. The retorts are about 25ft. high, rectangular in section, 103in. across, and 10in. wide at the top, and taper outwards towards the bottom to allow the free descent of the charge. Between the retorts there are the flues, in which the heating gas is burned, and ultimately goes away as waste gas, whose heat is used for steam raising.

The raw coal is fed into the retorts from overhead hoppers, the supply to which will be described later, through rotary valves into auxiliary hoppers that are virtually upward extensions of the retorts, but are not subject to the coking heat. From them it falls into the retorts where the volatile constituents are dispelled by the heat conducted inwards from the heating flues. The rate of descent of the charge, and consequently the period during which it is subjected to the carbonising effect, is dependent on the rate at which the coke is withdrawn at the bottom of the retort.

The bottom is formed as a curved plate, on which the weight of the charge rests, with a side opening closed by a star wheel having helical vanes. This wheel is rotated at a speed appropriate to the rate at which discharge is required by a reciprocating horizontal bar on which tappets can be fixed at any desired interval. The coke passing the star wheel falls into another hopper which will hold as much coke as is generally made in two hours. The bottom of this hopper is sealed by a valve that is opened

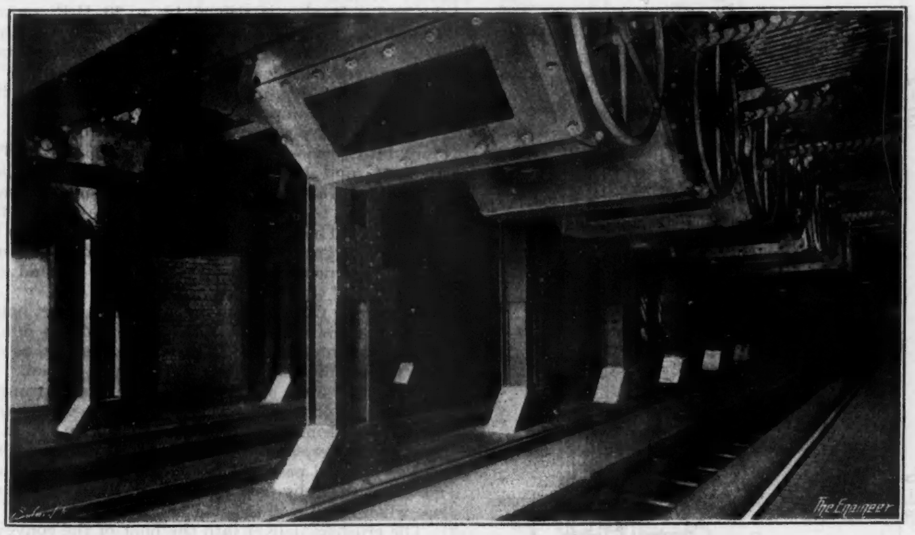


VIBRATING SCREENS AND ROTATING GRIZZLIES IN COKE SCREENING PLANT

Charging Hopper and Floor Levels of Gas Producers

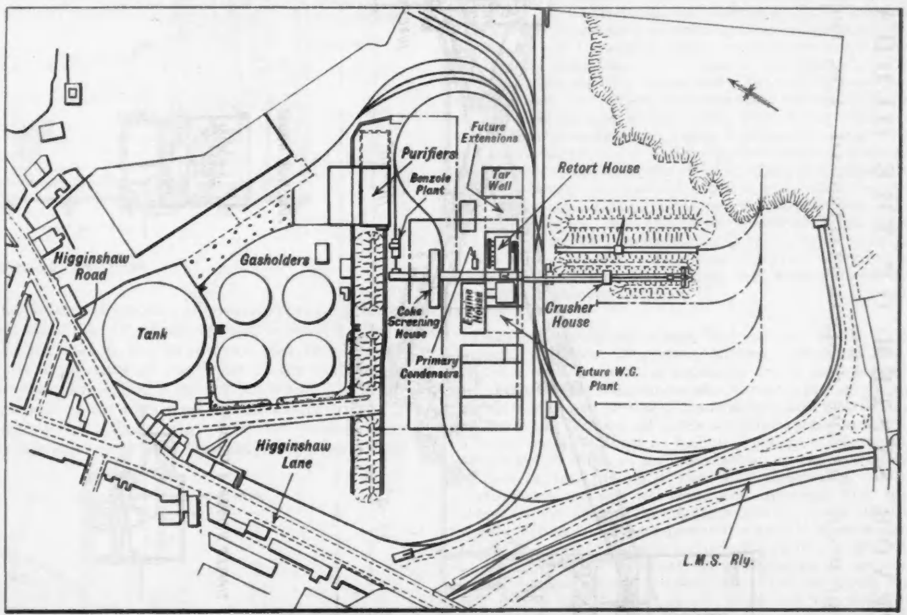
"Aeroplane" Distributor

every two hours for the discharge of the coke. It will thus be seen that the retort is sealed away from the atmosphere and there is a continuous downward flow of the charge, while the gas generated is taken off at the top into a collecting main. Each retort is provided with a mushroom valve in the off-take pipe, so that it may be isolated. Another main is provided on each side of the retort setting in which the gas is sprayed with hot ammoniacal liquor. The liquor is circulated round and round a system which includes wells for the collection of the tar washed out of the gas. The gas and the surplus liquor go on to the by-product recovery plant and the gas ultimately to the town's mains. One of the retorts at the end of the bench is provided with separate connections to a small purifying plant so that it can be used for unfamiliar brands of coal and the best carbonising procedure determined.



Coke Discharge Apparatus Below Main Retorts

The heat necessary for carbonising the coal is provided by gas generated in producers alongside the battery of retorts. There are seven producers in all, and they use a mixture of small coke and breeze from the retorts that is of such a low quality as to be hardly worth selling. The producers are of the stepped grate type and their form is shown in the sectional drawing on p. 351. They all discharge into one main for the distribution of the gas to the heating flues of the retorts, and are so equipped with doors, air and steam injection that they can be adapted to immediate requirements.



"The Engineer"

Map Showing Arrangement of Gasworks Plant

After passing through the heating flues the gases, naturally, have a considerable amount of sensible heat, and this is secured for useful purposes by passing them through either one of two waste heat boilers.

These boilers are arranged on the opposite side of the retorts to the producers, and either one of them is capable of providing nearly all the steam necessary to run the plant. The boilers are of the tubular type, and work under induced draught. The working steam pressure is 160 lb. per square inch, and the steam, except so much as may be necessary to send directly to the retorts and producers, is superheated in the waste gas flues. The feed water for the boilers is preheated by exhaust steam.

The gas made in the retorts first passes through a primary tar extractor of the Holmes cyclone type, and is then cooled in condensers of the tubular type, the "pull" on the retorts being determined by two Arca regulators controlling butterfly valves in the uptakes. It is then forced by exhausters into a secondary single-column condenser, where it is finally cooled to a temperature within 5 per cent. of that of the circulating water. The exhausters, by G. Waller and Son, Ltd., of Stroud, are of the four-bladed type, and are capable of delivering 200,000 cubic feet of gas per hour against a pressure of 50in. at the outlet and minus 6in. at the inlet when running at 60 revolutions per minute. They are driven by 80 H.P. non-condensing engines controlled by hydraulic-steam governors in correct proportion to the make of gas.

From the secondary condenser the gas passes through a Livesey washer and thence into a Holmes double-unit rotary brush washer. The washed gas is taken to some oxide beds, which were put down in connection with the old plant, for the removal of sulphur compounds. Air for the regeneration of the oxide *in situ* is supplied by a Connersville blower driven by the brush washer. The purified gas then goes to a Holmes debenzolising plant which recovers about 1 gallon of benzole for every ton of coal carbonised.

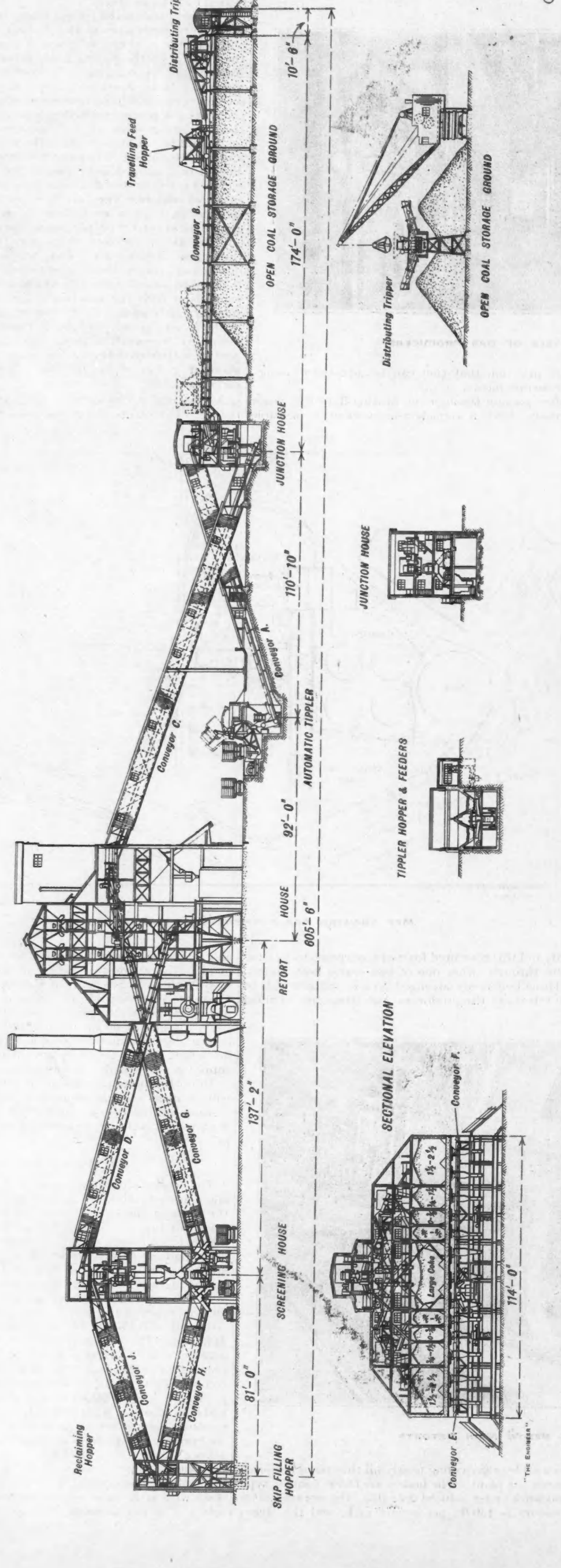
As the new works have to work in parallel with the other two plants, the gas is boosted up in pressure and delivered to the holders there through a 24in. main. There are two rotary four-blade boosters, by G. Waller and Son, Ltd., of Stroud, for this purpose. They are each capable of delivering 250,000 cubic feet of gas per hour against a pressure of 40in. W.G., when running at 60 revolutions per minute, and are driven by horizontal non-condensing engines of 65 I.H.P. Two small rotary Waller compressors supply gas to a high-pressure lighting system.

The other principal product of the works—coke—will be dealt with in connection with the conveyor system, but before going on to that part of the works it may be as well to give a brief account of the power plant.

The Power Plant.

The steam supply from the waste heat boilers is augmented by that from three Lancashire boilers at the back of the engine house, which are fired with coke and breeze. It is delivered from both sets of boilers to a common ring main underneath the engine-room floor at a pressure of 160 lb. per square inch, and the plant has been so laid out that the length of the piping has been reduced to a minimum.

In the engine-house there are besides the boosters already referred to three electric generating sets by Ashworth and Parker, of Bury, with General Electric dynamos. They are each of 125-kW capacity, with a 25 per cent. overload, and are of the enclosed compound type. There is a pass-out from the intermediate receiver from which steam, at a pressure of 30 lb. per square inch, is taken for the service of the retorts and producers, while the low-pressure cylinder exhausts against a back pressure of 5 lb. into a main that provides steam for feed-water heating and general service about the buildings. The dynamos are compound-wound, and generate current at 440 and 220 volts. The exhaust from the booster engines is dealt with in the same way as that from the generating sets. The engine-room, it might be mentioned in passing, is most pleasant as regards its cleanliness and airiness, which is in striking contrast to the atmosphere of most gasworks.



COAL AND COKE CONVEYOR SYSTEM OF THE OLDHAM GASWORKS

FRASER & CHALMERS ENGINEERING WORKS OF THE GENERAL ELECTRIC CO., LTD., ERITH, ENGINEERS

Distributing Tripper
Travelling Feed Hopper
Conveyor B.
OPEN COAL STORAGE GROUND
174'-0"
10'-6"
JUNCTION HOUSE
110'-10"
Conveyor A.
Conveyor C.
AUTOMATIC TIPPLER
92'-0"
RETORT HOUSE
605'-6"
137'-2"
Conveyor D.
Conveyor G.
SCREENING HOUSE
81'-0"
Conveyor J.
Conveyor H.
Reclaiming Hopper
SKIP FILLING HOPPER
Distributing Tripper
OPEN COAL STORAGE GROUND
JUNCTION HOUSE
TIPPLER HOPPER & FEEDERS
SECTIONAL ELEVATION
Conveyor F.
Conveyor E.
Large Coke
114'-0"
"THE ENGINEER"

The Conveyors.

Reverting now to the conveyor system which handles all the raw material in the way of incoming coal and the outgoing coke. It was supplied by the Fraser and Chalmers Engineering Works of the General Electric Company, and resolves itself broadly into sections for receiving coal from the railway and putting it either into stock or delivering it directly to the retort-house; with a subsequent system for taking away, grading, and delivering the coke. The lay-out of this plant is well illustrated by the line drawing alongside. It has a capacity for taking coal at the rate of 240 tons per hour from the railway siding on to the storage ground and delivering to the retort house, either from the store or directly from the siding at the rate of 80 tons per hour.

The coal trucks are first weighed on an Avery machine and are then tipped by a Mitchell machine capable of handling 20-ton trucks into an underground hopper. This hopper has two outlets at the bottom, beneath each of which there is a reciprocating feeder, capable of handling coal up to 12in. cube, that discharges on to the rising conveyor marked A on our drawing. This conveyor is of the Robins rubber belt type, 30in. wide, and is 119ft. long between centres. It rises 37ft. 6in., runs at a lineal speed of 375ft. per minute, and is driven by a 20 H.P. motor. At the head of this conveyor, in the junction house, there is a discharge chute having branches for leading the coal either directly to the storage conveyor B, or through crushers to the boot of the elevator C that feeds the retort house. The conveyor B runs over the stock pile on a trestle and is 30in. wide by 173ft. long, and has a slight rise of 9ft. towards the end. It also is driven by a 20 H.P. motor. Straddling this conveyor there is what is described as an "Aeroplane Trimmer," which comprises two short conveyors, each about 15ft. long, that rise at an angle of 18 deg. on either side and discharge the coal on to the dump.

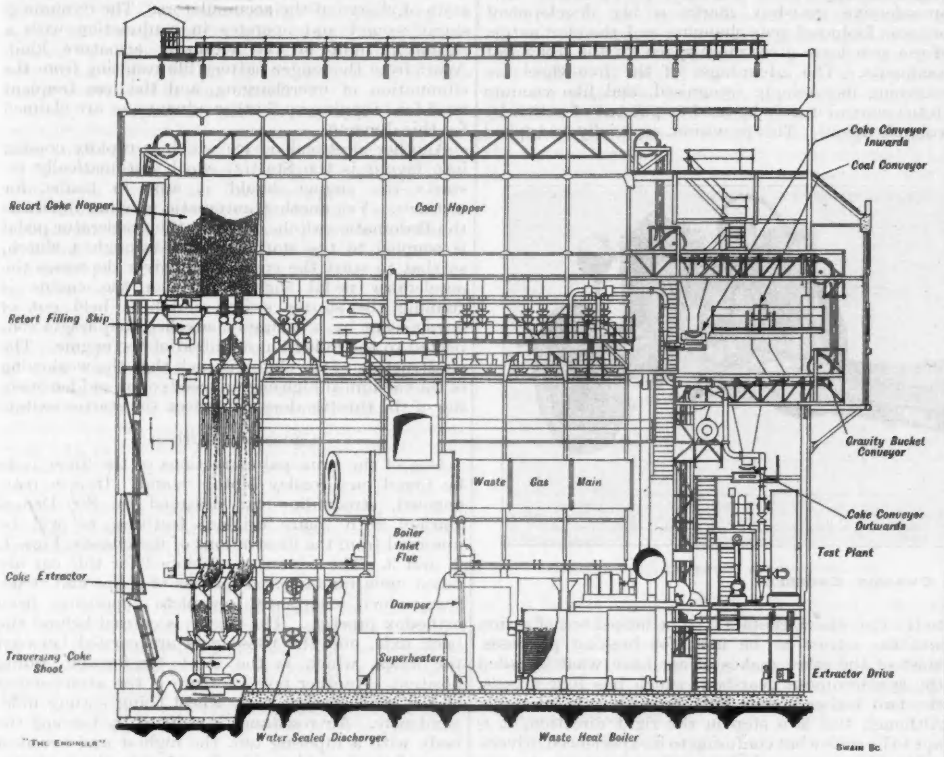
Coke Skip-Filling Station

For the purpose of returning the coal out of store into service the travel of the conveyor B is reversed, and it is supplied through a travelling hopper with a short feeder belt, 6ft. long, beneath the opening, to check the impact of the load on the main belt. The coal is picked up from the dump by a travelling grab crane, driven by steam, of 2 tons capacity, which has a radius of 50ft. beyond the centre line of the main conveyor.

On its way from the conveyor A to the retort house the coal, whether it goes directly or *viâ* the dump, must, probably, be passed through a crusher, as the aim is to purchase "run of the mine" coal. So two 30in. by 30in. Jeffery coal crushers are arranged in the Junction House. They are capable of breaking down coal from a maximum size of 22in. cube to 2in. and under, and are driven by 40 H.P. motors. Either one will pass 80 tons of coal per hour. There is, however, a by-pass shoot over the crushers for use when small coal is being handled.

The crushers deliver into the boot of the conveyor C, which goes to the retort house. This conveyor is also of the Robins type, but is 24in. wide, as its capacity is intended to be 80 tons per hour. It is 212ft. long, has a rise of 55ft., travels at a speed of 225ft. per minute, and is driven by a 10 H.P. motor. Towards the upper end this conveyor runs over a Westminster weighing machine, which is guaranteed to give the weight of the coal delivered to within 0·5 per cent.

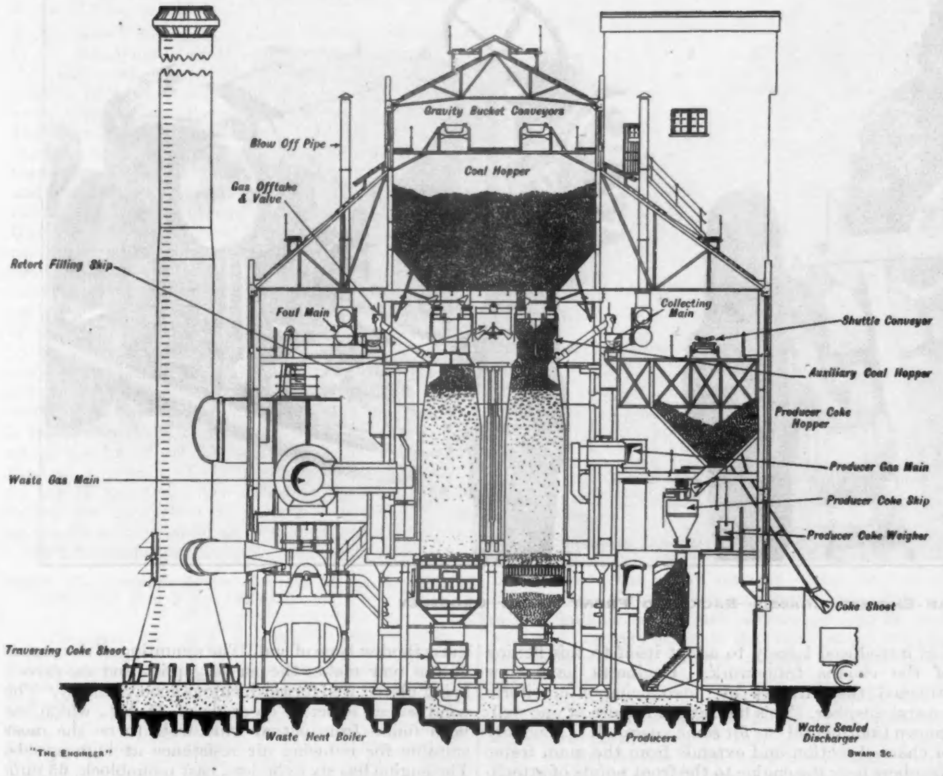
The conveyor C delivers into a gravity bucket conveyor that encircles the retort house in a vertical plane. Its route can best be followed in the drawing of the retort house. This conveyor, which has a capacity of 100 tons an hour, first takes the coal up and over the bunkers that feed the retorts, and then drops down to pick up the resultant coke and raise it up to a level for feeding the outgoing conveyor D.



Retort House—Longitudinal Section

This conveyor D has a capacity of 50 tons of coke per hour and has a length of 142ft., while its rise to the screening house is 42ft. It runs at 260ft. per minute, and is driven by a motor of 5 H.P.

In the screening house the coke is passed over rotary grizzlies and vibrating screens to separate it out into sizes ranging from over 2½in. down to breeze. All these sizes are sent into separate bunkers. It is noteworthy, in view of the usually unpleasant dusty atmosphere of such operations, that, while we climbed to the top of the screening house immediately after a charge had been passed through, the air quickly cleared, the floor was already in process of being swept up, and the surroundings of the plant gave little indication of the activities within. We also noticed that the chutes leading into the hoppers were well extended to leave the coke little free fall, with a consequent reduction in the amount of fines produced.



Retort House—Cross Section

The coke can be taken out of the hoppers to several alternative destinations, by means of two conveyors E and F beneath the outlets—see sectional elevation—each about 70ft. long, and both running towards the centre, or it may be discharged directly into carts for dispatch from the works. The conveyors may deliver to a belt conveyor G, which takes coke back to the retort house for use in the producers and the Lancashire boilers, or to another conveyor H for delivery to an automatic skip-filling hopper from which it is removed by means of an overhead steam crane to the coke storage yard. Coke may also be passed directly from the conveyor D to the conveyor J, and thence, by means of the grab crane, to a stock pile. This pile can be recovered by using the crane and reversing the conveyor J to take it back to the screening plant. There is also a coke-washing plant for medium sizes that is served by the skip crane.

The Laboratory.

Before closing this account some reference should be made to the laboratory, which is built on similar lines to the engine-house and the corresponding meter house, which go far to assist in the scientific control of the works, while the mess and lavatory accommodation for the staff is excellent.

Literature.

SHORT NOTICES.

Mechanical Refrigeration. By Hal Williams. Fourth edition. London: Sir Isaac Pitman and Sons, Ltd. 1933. Price 20s.—When a book reaches its fourth edition, and that only six years after the third was published, it may be judged with certainty that it has been accepted as the standard work on the subject. When, in addition, a glance at the preface indicates the possession by the author of a delicate sense of humour, one is quite unreasonably prepossessed still further in favour of his book. Whereas, when the third edition was published only two years after the second, the author found that the necessary alterations brought about by the ordinary course of development were few, in this new edition many new illustrations have been included to mark the march of progress. Notable developments have been made in the use of "dry ice"; in refrigerated trucks and other vehicles; in the freezing of fish and meat, and also in the design of abattoirs. The reviewer fears that Mr. Hal Williams is likely to suffer for the rest of his natural life the mixture of gratification and embarrassment he has already endured on three occasions, at intervals, caused by the readiness of the sale of his book and the rapidity of development of mechanical refrigeration.

The Sanitation of Water Supplies. By Murray P. Horwood. London: Baillière, Tindall and Ccx. 1932. Price 7s. 6d.—This book, an American one, is intended particularly for students of municipal sanitation and public health. While the author points out that the subject may be divided into the three aspects, laboratory, public health, and engineering respectively, he is mainly concerned with the first two. Opening with a short history of the rise of Municipal Sanitation and Public Health, the remainder of the first seventy-seven pages is devoted to sources of and the development of water supplies; the requirements of a potable supply and the effect of water as a vehicle for disease. Nearly one hundred pages more are then devoted to purification, softening, filtration, and disinfection. The examples quoted, and the methods described, as might indeed be expected, are all those of the country of origin of the book—America. As a general survey, therefore, of American conditions the volume has some interest for engineers in this country.

Electrical Transmission and Distribution. By E. T. A. Rapson. London: Humphrey Milford. Price 12s. 6d.—This is a book written for students, but it may possibly also prove useful to engineers who have not hitherto given much attention to electrical transmission and distribution problems. It is based on notes compiled by the author in lecturing on the subject to technical college students and is intended to serve as an introduction to the specialised treatises on this branch of electrical engineering. Many questions are set and answered and overhead lines and cables are covered. Descriptions are given of all the modern cables and feeder protective gear. A somewhat notable feature of the book is the inclusion of a chapter on the British "grid," in which the well-known advantages claimed for the scheme are set forth. On the whole, the book covers the subject pretty well, but no reference appears to be made to voltage regulation by means of A.C. feeder regulators, which show signs of meeting with widespread application.

The Mechanism of the Car. By Arthur W. Judge. Second edition. London: Chapman and Hall, Ltd. 1933. Price 4s.—This little book is Volume III. of Motor Manuals, a series published with the object of meeting the needs of motor owners and users. Since the first edition of the book was published in 1925 considerable progress has occurred in the design of automobiles, and a careful revision of the work and the inclusion of some new matter has been found necessary. The book deals in successive chapters with all the various parts of a car, such as the chassis, axles and steering, the clutch, gear-box and other transmission details, brakes, and wheels. It is not concerned with the engine, as the title might be thought to imply. Modern developments such as pre-selective and synchro-mesh gear-boxes are described, as well as hydraulic, pneumatic, and vacuum-servo brakes.

BOOKS RECEIVED.

British Rainfall, 1932. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 15s. net.

Mayfair to Maritzburg: Reminiscences of Eighty Years. By Gustave Hallé. London: John Murray, Albemarle-street, W.1. Price 12s. net.

Hydraulics. Third edition. By H. W. King and C. O. Wisler. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 16s. 6d. net.

Office Administration for Manufacturers. By R. A. Mills. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 10s. 6d. net.

Die Statik im Eisenbetonbau. By Dr.-Ing. Kust Beyer. Berlin: Vertagbuchandlung Julius Springer, Linkstrasse 23–24, W.9, Germany. Price 32·50 marks.

A Text-book of Fire Assaying. Second edition. By E. E. Bugbee. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 18s. 6d. net.

Ten Years' Index to Volumes 60–69 (1922–1931) *of the Institution of Electrical Engineers' Journal.* London: The Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C.2. Price 10s. 6d. net.

Motor Car Show at Olympia.

No. I.

Although the motor car exhibition which is being held at Olympia under the auspices of the Society of Motor Manufacturers and Traders will no doubt prove as attractive to the public as most of the twenty-six annual Shows which have preceded it, much of the curiosity of motor vehicle users has already been satisfied by the previous publication of the chief features of the 1934 products of the principal British makers. It is claimed that there are altogether some 500 firms exhibiting, but by far the largest number is to be found in the accessories and garage and service equipment sections. A notable development in this connection centres in tools for the complete renovation of engine cylinders and valves, and appliances for testing the roadworthiness of cars, as and when required. Particular interest will be found by engineers in the testing plants to check performance and brake adjustments, some of which can now be applied while cars are being lubricated.

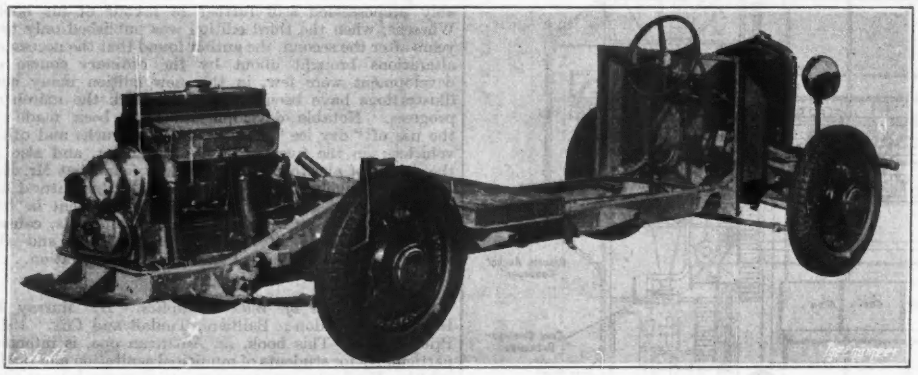


Fig. 1—Rear-Engined Chassis—Crossley

The motor boat section is well patronised by the leading builders. The exhibits range from an "Aquaplane" for towing behind motor boats for "surf-riding," to a full-powered cabin cruiser. In the latter type of craft there appears to be a growing tendency to use two medium-powered engines instead of one large engine, a change which gives increased reliability and easier handling of the boat. A feature of this section is the increased speeds of small craft, such as dinghies and yacht tenders. Nearly all the inboard motor boat engines are now provided with electric lighting and starting equipments, and a dashboard with instruments and switches. There is a good range of compression ignition engines, some of which are light enough in weight for installing in 30ft. cruisers.

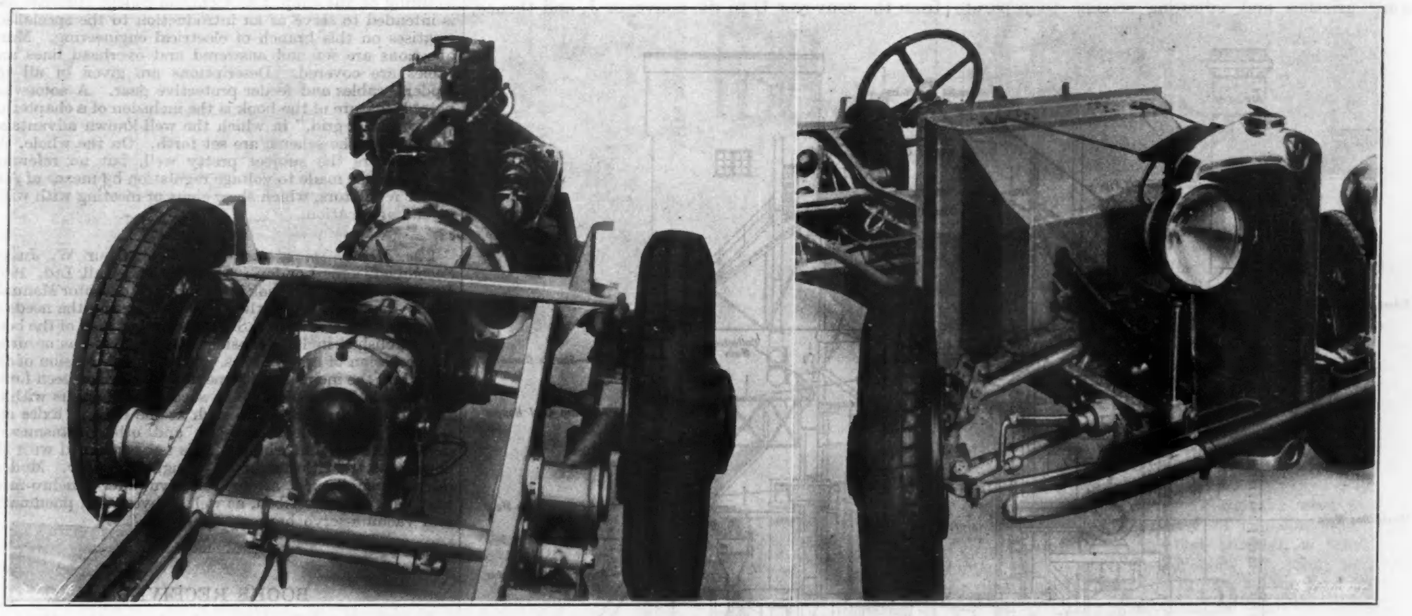


Fig. 2—Rear-Engined Chassis—Back and Front Axles—Crossley

With regard to the new car designs, as most of our readers are already informed, the outstanding feature this year has to do with gear-box construction and design. The improvements which have been introduced are of various kinds—some more complicated than others—to enable easy and quiet changes of gear to be effected. The most prominent perhaps is the Wilson epicyclic gear-box, which was originally introduced by the Armstrong-Siddeley Company, and latterly adopted by the Daimler and allied companies in conjunction with the fluid fly-wheel. The pre-selective gear-box marks a big development towards foolproof gear changing and the elimination of the gear lever gives more space for the front seat occupants. The advantages of the free-wheel are becoming increasingly recognised, and like vacuum clutch control it may be used or put out of action by a simple device. This provision, especially as applied to the free wheel, enables it to be locked out of action and the engine to be used for braking purposes. Most of the other makes of car have what is called the synchro-mesh gear-box, which has four speeds, the two higher speeds only being always in mesh. Although this is a step in the right direction, it is apt to be somewhat confusing to inexperienced drivers.

Much prominence is being given in the motor car industry to the stiffening of the chassis framework. Some of the more popular makers of cars, on account of lightness, have not hitherto put sufficient metal into the frames, or if they have done so have put it where it is least needed. The result has been twisting and distortion of the framework, which has caused troubles with the body work. The Weymann body was introduced largely to adapt itself to this flexing of the chassis framework. Engineers have now stiffened their frames by introducing a cruciform central member. This has been a feature of one well-known Continental car for some years. It is generally of channel section and extends from the main frame members near the engine to the front points of attachment of the rear springs. The centre of the cross is made hollow, so that the propeller shaft from the gear-box to the rear axle may pass through it. This form of construction will go a long way towards preventing the body noises common in some makes of car, which are produced by the flexing and relative movement of the parts of the wooden body frame.

As regards ignition, the great majority of 1934 cars will have the coil and battery form with automatic timing over part of the range and manual control for the rest. The Scintilla vertical magneto, which we described in connection with last year's Show, will also be seen on some cars. This device has the merits of accessibility and synchronous timing, with automatic control. Electricity will play a greater part than ever in next year's cars. Ignition, starting, lighting, supplying fuel to the carburetter from the tank, wind-screen wiping, and horn blowing will all be done by electrical means. The firm of Lucas is introducing for these purposes an improved form of dynamo, the output of which varies with the state of charge of the accumulators. The dynamo is shunt wound and operates in conjunction with a regulating unit of the vibrating armature kind. Apart from the longer battery life resulting from the elimination of overcharging, and the less frequent need for 'topping up," other advantages are claimed for this dynamo.

Another electrical device which is rapidly coming into favour is the Startix, which automatically restarts the engine should it stop in traffic, for instance. Yet another automatic starting device is the Pedomatic switch, in which the accelerator pedal is coupled to the starter switch through a clutch, so that to start the engine the driver depresses the accelerator pedal slightly. When the engine is running the starter switch clutch is held out of engagement by a vacuum-controlled diaphragm connected to the induction manifold of the engine. The construction of the clutch is such that the weakening of the vacuum at high engine speeds or on sudden opening of the throttle does not affect the starter switch.

Crossley Motors.

One of the principal attractions of the Show is to be found on Crossley Motors stand. It is a rear-engined, stream-line car designed by Sir Dennis Burney with many original features, as will be observed from the illustrations of the chassis, Figs. 1, 2, and 3. The advantages claimed for this car are based upon fundamental reasons of shape and structure, which incorporate complete departures from orthodox practice. The engine is carried behind the back axle, and the passengers are carried between the axles, which is the most comfortable riding position. Another novel feature is the arrangement of the road springs, each wheel being sprung independently. Air resistance is reduced by forming the body with a tapering tail, the highest and broadest part of the body being in front, as in the case of a bird. A self-changing pre-selective gear-box of the Wilson type is placed immediately in front of the back axle, and the final drive is by spiral bevel gear, and thence through a short cardan shaft universally jointed at both ends to each rear wheel. The body is built exceedingly low without loss of headroom, as there is no transmission shaft from front to rear, as in the orthodox type of car. The mounting of the engine at the rear makes the car very quiet, and the driver, being placed well forward, enjoys good visibility. The wind screen is set at an angle of 35 deg., which has been found from actual wind tests to be the most suitable for reducing air resistance at high speeds. The engine has six cylinders, cast monoblock, 65 mm. bore by 100 mm. stroke, the R.A.C. rating being 15·7 H.P. It has overhead valves and forced lubrication to all main bearings, and also to the big end bearings. The carburetter and magneto are very easy of access. By lifting the rear bonnet the engine can be reached with ease, as there are no wheels or wings to lean over. The Wilson gear box gives four speeds. The wheel base of the car is 9ft. 8in.; front track, 4ft. 8in.; rear track, 3ft. 7in.; overall width, 5ft. 6in.; ground clearance, 8in.; and turning circle, 35ft.

(To be continued.)

World's Oil Supplies.

By JOHN B. C. KERSHAW, F. Inst. Fuel.

THE issue of THE ENGINEER for August 7th, 1931, contained an article by the writer in which the position of the Fuel Oil Industries at that date was discussed. In the present article the figures of the earlier one have been brought up to date, and their bearing upon the prospects of the various processes now being employed for the production of oil from coal is considered in some detail.

There is a tendency at the moment, especially amongst financiers and politicians, to raise expectations unwisely concerning the possibility of extracting oil from coal, and thus of making this country independent as regards our future supplies of fuel oils. It is advisable therefore that the real facts of the position should be made clear and published as widely as possible, in order that the magnitude and difficulties of the problem may be realised more fully by the general public. The decision of the Government to grant a rebate of the Excise Duty amounting to 4d. per gallon upon home-produced petrol after April 1st, 1934, has certainly rendered the prospects of these processes more favourable. The writer is doubtful, however, whether more than one or two of the processes will be able to produce light oils at a price which can compete with the imported petrol, even with this rebate of half the Excise Duty to help them, and the figures given below for our consumption of petrol and other light oils indicate what an enormous development of these new processes will be necessary before we are rendered independent of our external sources of supply.

THE WORLD OUTPUT OF CRUDE OIL.

Table I. gives the official figures for the world production of crude oil in the pre-war year 1913 and for the post-war years 1922 to 1932, expressed in thousands of barrels. The percentage of the total supply which comes from the United States is given in the last column of the table. The figures show that the world production of crude oil attained its peak in 1929, when it reached the huge total of rather over 1000 million barrels, which is equivalent to 42,000 million gallons. Since 1929 the world production has been curtailed, largely owing to the trade depression and consequent falling off in demand, and for 1932 the total output of the oil wells had fallen to 781,845,000 barrels, or by 22 per cent. The United States proportion has also fallen away very rapidly, for fresh oilfields have been developed and brought into operation in various quarters of the world since 1923, when the United States oilfields supplied 72 per cent. of the total world production of mineral oil. The percentage has now receded to 59·9, which represents a reduction of 13·1 per cent. in the ten years, and the predominant position occupied by the United States oil companies in the world market seems now nearly ended. The position is made clearer by the two diagrams printed below, which are based on the figures of Table I., and the gradual approach of the two curves in Diagram 1 to the 50 per cent. line indicates that by 1936 or earlier the production of "Other countries" in the aggregate will be equal to, if it does not exceed, the United States output.

TABLE I.—*Comparative Figures for the Total Production of Crude Oil in the Years* 1913–1932, *from Figures Compiled by the U.S. Geological Survey (in thousands of barrels of 42 U.S. gallons).*

Year.	World.	U.S.A.	U.S. percentage.
1913 ..	.. 383,547 ..	.. 248,446 ..	.. 64·7
1922 ..	.. 858,715 ..	.. 557,531 ..	.. 64·9
1923 ..	.. 1,018,900 ..	.. 732,407 ..	.. 72·0
1924 ..	.. 1,012,927 ..	.. 713,940 ..	.. 70·4
1925 ..	.. 1,067,566 ..	.. 763,743 ..	.. 71·5
1926 ..	.. 1,095,934 ..	.. 770,874 ..	.. 70·4
1927 ..	.. 1,262,582 ..	.. 901,129 ..	.. 71·4
1928 ..	.. 1,324,733 ..	.. 901,474 ..	.. 68·0
1929 ..	.. 1,482,517 ..	.. 1,006,587 ..	.. 67·9
1930 ..	.. 1,418,723 ..	.. 898,011 ..	.. 63·3
1931 ..	.. 1,372,532 ..	.. 851,081 ..	.. 62·0
1932 ..	.. 1,305,563 ..	.. 781,845 ..	.. 59·9

NOTE.—The 1932 figures are not estimates, but are the Bureau of Mines figures.

TABLE II.—*World Production of Crude Oil (in thousands of barrels) for Four Years,* 1929–32.

Country.	1929	1930.	1931.	1932.
United States ..	1,007,323	898,000	851,081	781,845
Russia*	100,583	136,835	165,576	158,050
Venezuela	137,472	137,675	116,613	116,300
Roumania	34,689	41,680	49,127	54,160
Persia	42,145	45,420	44,376	49,470
Dutch East Indies ..	38,072	40,100	35,539	39,000
Mexico	44,688	39,530	33,039	32,805
Colombia	20,385	20,346	18,237	16,417
Argentina	9,391	8,910	11,709	13,000
Trinidad	8,716	9,120	9,744	10,100
Peru	13,422	17,458	10,089	9,900
Equador	1,350	1,559	1,762	1,595
Other countries ..	25,805	22,092	25,640	22,921
Totals	1,484,041	1,418,725	1,372,532	1,305,563

* N.B.—Includes Sakhalin production.

Table II. gives the details of the crude oil production of the leading individual countries for the past four years, and from this table it will be seen that Russia and Venezuela are the two countries which, after the United States, are contributing the largest share to the world's supplies of mineral oil. Roumania, Peru, the Dutch East Indies, and Mexico follow in the order named, and it will be noted that some of these countries have reduced their output for 1931 and 1932. It would be premature to conclude, however, that these particular oilfields are exhausted, for their restriction of output has been dictated chiefly by the desire to conserve their supplies until the demand has increased and the price obtainable for the crude oil has reached a more remunerative figure.

Considering now the statistics for the consumption of oil in this country, Table III. gives the figures published by the Board of Trade, showing the imports of oil for the pre-war year 1913 and for the post-war years 1928 to 1931, expressed as thousands of gallons.

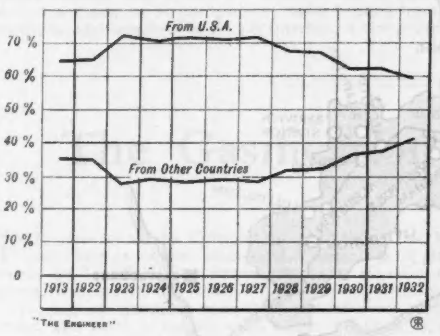


DIAGRAM I.—OUTPUT OF CRUDE OIL

TABLE III.—*The Imports of Oil into the United Kingdom (in thousands of gallons) for the Pre-war Year* 1913 *and for the Post-war Years* 1928–31.

Character of import.	1913.	1928.	1929.	1930.	1931.
Crude oil	1,108	498,001	487,348	460,968	344,370
Refined oils—					
Petrol	100,858	734,737	810,084	954,609	905,205
Fuel oil	161,011	450,876	405,610	491,089	485,814
Lamp oil	157,141	189,763	255,032	245,792	270,946
Lubricating oil ..	67,962	105,429	98,018	101,937	97,531

The total imports of these five types of oil are seen to have increased from 488 million gallons in 1913 to 2103 million gallons in 1931, or more than fourfold.

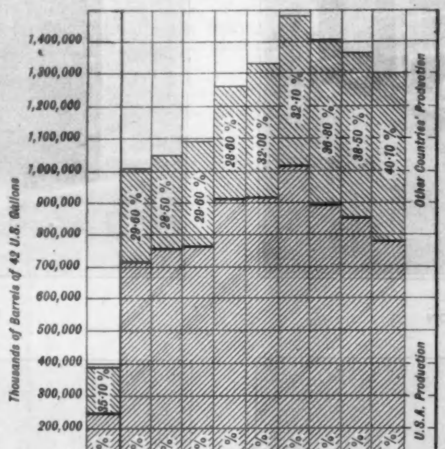


DIAGRAM II.—OUTPUT OF CRUDE OIL

If one takes the petrol imports alone the increase in the same period is seen to have been from 101 million gallons up to 905 million gallons, or ninefold, and one may estimate that the consumption has kept pace with the imports, in spite of the increased storage capacity at the importing centres.

The aggregate value of the fuel oil imported in 1931 amounted to close upon 25 million pounds sterling, at the ports of entry—that is, before the Excise Duty or distribution costs have been added to the original cost of the oil. More than one-half of this total represented the cost of petrol, for in 1931 the total value of imported petrol was £13,671,444, which is equivalent to an average price of 3·62d. per gallon at the port of entry. Lamp oil came next with a value of £3,499,883, equivalent to 3·10d. per gallon; while our imports of crude oil cost us £2,974,662, or 2·07d. per gallon. The balance of our imports was made up of lubricating oil, valued at £4,018,021, and fuel oils, valued at £3,499,883, and the latter cost us on the average only 0·98d. per gallon at the port of entry. It is rather unsatisfactory to note, however, that our imports of crude oil have declined during the last few years, and are now only one-third of the volume they were in 1913. There is no reason why the cracking and refining of crude oil should not be carried on in this country rather than in the country of origin, and it might be well if the excise authorities took some steps to encourage the import of crude oil rather than of the refined products which are obtained from it.

Finally, in comparison with the above figures, the estimated production may be given of the existing plants for obtaining fuel oils from coal when the extensions now in progress are completed, and the new Bergius plant for the hydrogenation of coal is in operation. We shall then be in a position to produce about 80 million gallons of light fuel oils per annum or about 9 per cent. of our present consumption, and this shows that many years must elapse before the whole of our requirements of light and heavy fuel oils can be met by our home producers.

Future Prospects of Low-Temperature Carbonisation.*

THE present-day low-temperature carbonisation industry is on a small scale. Not more than about 1 per cent. of the household fuel burnt in open grates is produced by low-temperature carbonisation processes. The economics of these processes depend essentially on the difference in price between small and large coal. An expansion of the industry must of necessity have a profound influence on the price, both of the raw material for the process and of the finished product, and it is important to consider, whether, should supplies of low-temperature fuel become abundant, the "manufactured product" could successfully compete with the "raw material."

The quality of coal suitable for low-temperature carbonisation for the production of a household fuel depends to such an extent on the process used that it is not possible to generalise. For example, one process may be able to deal only with non-caking or feebly caking coals, whilst another may demand a strongly caking coal for its successful operation. The choice of process, or of coal for a process, can be determined satisfactorily only by trial.

Supplies of cheap coal suitable for low-temperature carbonisation (*e.g.*, of low ash content) are not unlimited. An industry, established at the collieries, swollen to such a size as to be able to supply the major part of the nation's household fuel, would have to pay a price not much, if any, less than the average pithead price of all grades of coal, which is, at present, about 13s. 3d. per ton. The finished product would compete with large house coal, now commanding a price at the pithead of about 27s. per ton.

Theoretically, a low-temperature coke should be valued at a higher figure than coal; for a fuel that retains the qualities of coal for use in open grates and is also smokeless has material advantages. Nevertheless, it is doubtful whether such advantages of quality as a low-temperature coke might possess would cause it to be valued more highly than house coal if both were equally available. Moreover, it must be remembered that the market for house coal has been decreasing, owing to the substitution of gas and electricity and of central heating plants burning high-temperature coke. Equally, it must be presumed, the market for a low-temperature coke as a domestic fuel might be decreasing.

When considering the future prospects of low-temperature carbonisation as an industry, therefore, it would not be wise to count on a greater difference in price between the raw material and the finished product than at present exists between the average price at the pithead of all grades of coal and the price of house coal, a difference of about 13s. 9d. The operating costs for a 200-ton plant would be about 10s. per ton of coal carbonised, equivalent to about 14s. 3d. per ton of fuel produced.

With expansion of the industry, closer attention could be paid to the tar and gas as sources of revenue. Low-temperature tar, if reasonably free from solid matter, is a suitable raw material for hydrogenation, and the whole of it, including the pitch fraction, can be so treated. When bulk supplies of low-temperature tar are available, hydrogenation should be profitable. The gas is usually of high calorific value, being rich in hydrocarbons, a fact which would commend it for use as a motor fuel, inasmuch as, for a given capacity of cylinders for compressed gas, a motor lorry, for example, would have double the touring range if the calorific value of the gas were 900 B.Th.U. instead of the 450 B.Th.U. usual for coke-oven gas. A gas rich in hydrocarbons could also be subjected to pyrolysis (*i.e.*, heat treatment) for the production of benzene.

General Conclusions.—At the present time, the difference in value between the raw material (small coal) and the finished product (domestic fuel) being great and the output being small, the manufacture, by a suitable process, of a low-temperature coke of good quality should prove a profitable undertaking for colliery companies.

With the growth of the low-temperature carbonisation industry to the point where most of the domestic market would be met, the prices of small coal and house coal (and, thus, of the manufactured fuel) would approach each other, so that the margin allowable for operating costs would be restricted. It is estimated that a plant having a throughput of less than 200 tons of coal per day might not then be sufficiently profitable.

IT is proposed that a Bill should be promoted to form a Joint Municipal Transport Board operating throughout the area of nine local authorities in South-East Lancashire and East Cheshire, with Manchester and Salford as the focal centre of the new system.

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* From a leaflet, Memorandum No. 12, issued by the Utilisation of Coal Committee of the Institution of Mining Engineers.

A New Rural Electrification Scheme.

OF the rural electrification schemes that have been made possible by "grid" secondary lines, the Ringmer and District Electricity Undertaking, embracing an area of some 63 square miles of picturesque country, should easily prove to be one of the most successful. With several important industrial concerns at the Lewes end and agricultural and residential districts, as indicated in the map, Fig. 1, the area which extends along under the lee of the South Downs between Lewes and Eastbourne offers a good field for electrical enterprise. Factories, farms, country houses, villas, and shops are now reaping the benefits of electricity derived from the Ringmer and District Supply Company, Ltd., financed by Johnson and Phillips, Ltd., of Charlton, S.E.7, who manufactured and erected all the plant, cables, and overhead lines. Broadly speaking, the area lies between Lewes and Ringmer in the centre, Plumpton to the west, and Alfriston to the south. A special order was granted by the Electricity Commissioners to the company in 1930, and an efficient and extensive distribution system has since been provided.

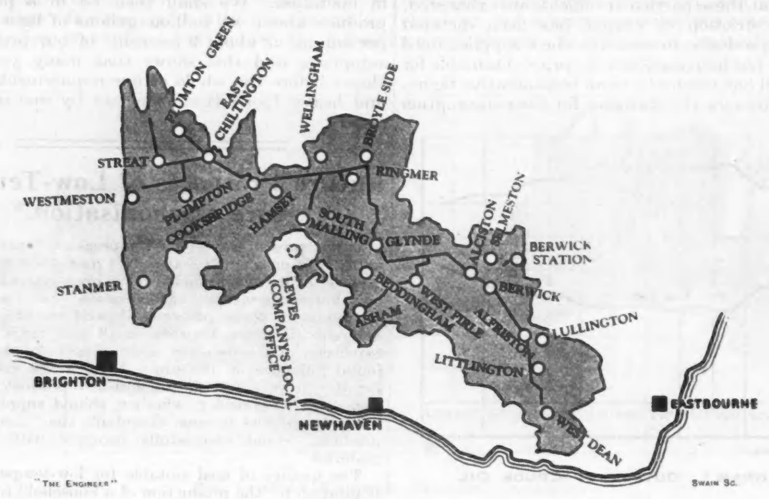


Fig. 1—Map of Ringmer and District Electrified Area

Three-phase current at 10·5 kV is supplied to the undertaking by the Central Electricity Board through the sub-station—Fig. 2—which is tapped on to the 33-kV secondary "grid" line between Eastbourne and Newhaven. It is situated at Asham, Rodmell, just beyond the Lewes urban boundary, and contains two Johnson and Phillips 5000 kVA automatic on-load tap-changing transformers, which reduce the pressure to 10·5 kV for the Ringmer transmission system. In the company's sub-station adjacent to that belonging to the Central Electricity Board there are two incoming and five outgoing high-tension feeder panels with metering and protective equipment for the supplies at this point. While the two incoming panels control the 5000-kVA transformers, the outgoing panels deal with the supplies to the Alpha Cement Company, Ltd., Carbo Products, Ltd., and to the company's main transmission system.

The Cement Company's main works are on the sub-station site and a supply is given to them through two 1500-kVA Johnson and Phillips outdoor transformers, which reduce the pressure from 10·5 kV to 440 volts for motors in the factory. Two 500-kVA transformers of the same type and make installed about 500 yards distant are supplied through a length of cable and serve for providing the Cement Company's smaller works with current. Overhead 10·5-kV lines are employed, mainly for the transmission of electrical energy from the supply company's main sub-station to the distribution centres. This transmission system is, roughly speaking, in the form of a short stemmed T with the Asham main sub-station at the base. On the north boundary of Firle Park at Gibraltar Farm the stem meets the main lines and at this point there is a special four-member pole, as shown in Fig. 4, which carries switchgear for controlling the high-tension lines running to the east of the Alfriston area in the south, and north to Ringmer, with a subsequent veering round to the west to Plumpton. The switchgear on this pole consists of the new Johnson and Phillips "E.K.C." oil circuit breaker with an automatic reclosing device which, when minor self-clearing faults occur, recloses the breaker three times in succession with increasing time lag on each occasion. After the final reclosing the circuit breaker remains open and an indicator shows which section of the line is giving trouble. Obviously the device offers the advantages of avoiding the necessity for a lineman to tramp perhaps miles in order to reclose a breaker that has been opened by a minor fault, and consequently reduces the time the supply is interrupted.

The main overhead feeder from the Asham sub-station to the Gibraltar Farm four-member junction pole, shown in Fig. 4, consists of 0·05 square inch equivalent steel core aluminium conductor, whilst the lines running north and subsequently west and east and then south are composed of 0·025 square inch equivalent cadmium copper. For the most part the high-tension conductors are carried on wooden poles, as shown in Fig. 5, in which the pole to be seen in the foreground carries a 11-kV 25-kVA transformer and fuses. The design of the cross arms carrying the lines is said to be the outcome of much investigation in connection with eliminating troubles caused by birds.

Although for the most part the high-tension conductors are carried on wooden poles, concrete poles are also employed, as shown in Fig. 6, which illustrates a terminal pole with an 11-kV 25-kVA transformer, high-tension fuses, low-tension switch, and three outgoing low-tension lines. While the pole span averages 425ft. on normal runs of line, owing to the particular configuration of the ground in some places spans of between 450ft. and 550ft. have been adopted. Pole-mounted transformers are provided at convenient points for reducing the line pressure to 230 volts single-phase for lighting and for general domestic purposes, and to 400 volts three-phase for power purposes. Generally speaking, the outgoing low-tension leads from the transformer are taken to a waterproof ironclad switch and fuse and then to insulators fixed to the pole, from

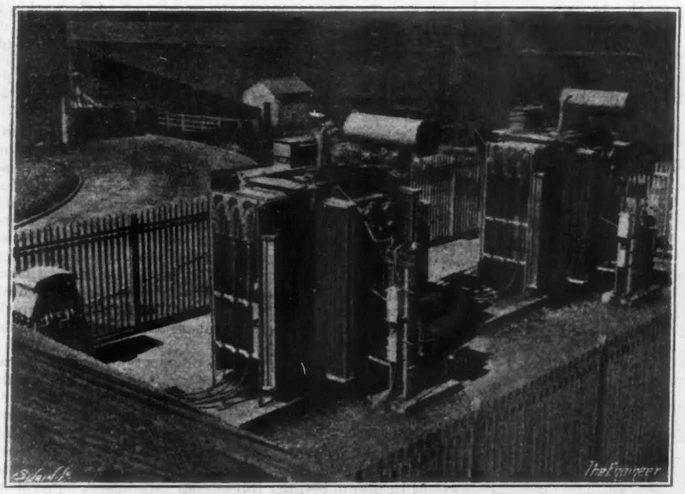


Fig. 2—The Asham Sub-Station

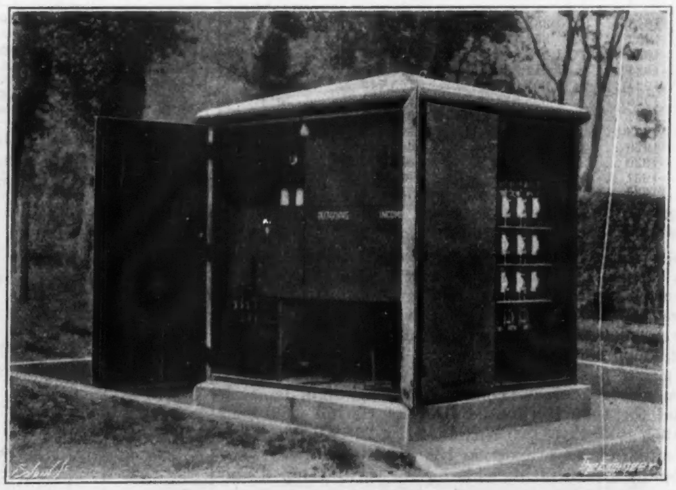


Fig. 3—Kiosk at Alfriston

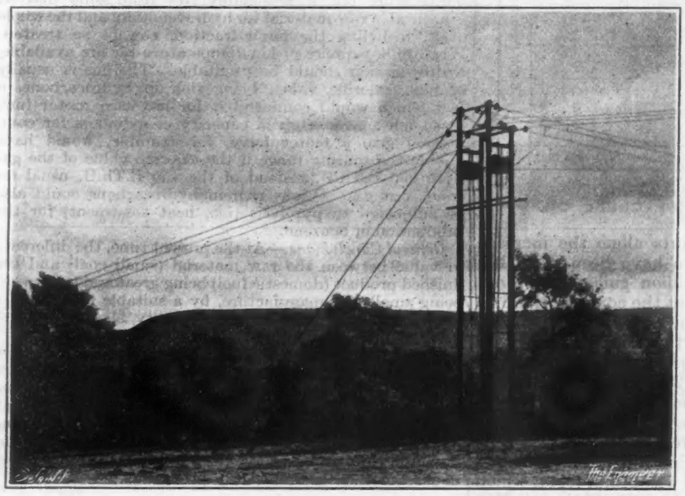


Fig. 4—Junction Pole at Gibraltar Farm

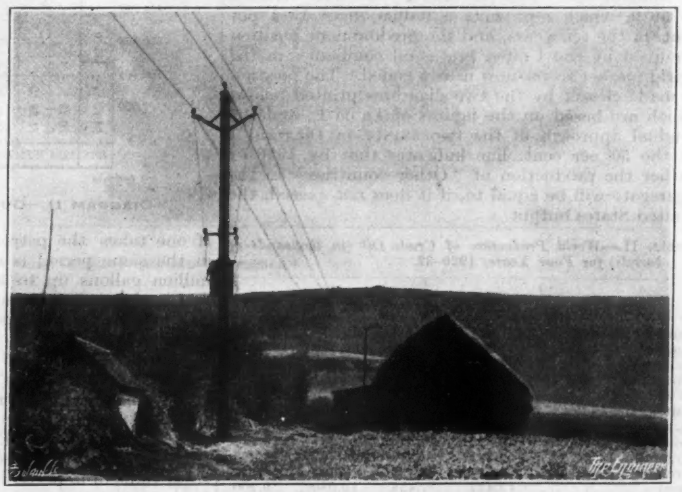


Fig. 5—Straight Line Wood Transformer Pole

which the low-tension service lines are run to the consumers' premises.

Except in a few places in which it has been necessary to preserve the special amenities of the district by the use of underground cables, the low-tension distribution system is overhead. Service lines consisting of " P.B.J." cable and bare copper conductors are connected to the distributors by means of Johnson and Phillips "Wonpeace" insulators fixed to the pole and building respectively, while the service is continued into the premises by rubber insulated fire-resisting cable passing through porcelain tubes. Where a row of terraced houses is to be supplied special low-tension lines have in some cases been erected and services are tapped off at intervals for supplying groups of houses from convenient points, the special fire-resisting cable being run along the faces of the houses. Individual services are then taken off to each consumer through cast iron tee boxes. Where it has been necessary to employ underground distribution cables a length of high-tension cable has been brought from a neighbouring terminal pole outside the area to be supplied and has been connected to a combined transformer and feeder pillar which feeds low-tension distributors, all service connections to the individual consumers also being kept underground. For a relatively large demand in places in which the amenities must be preserved, such as in the old world village of Alfriston, a kiosk sub-station has been provided, as shown in Fig. 3.

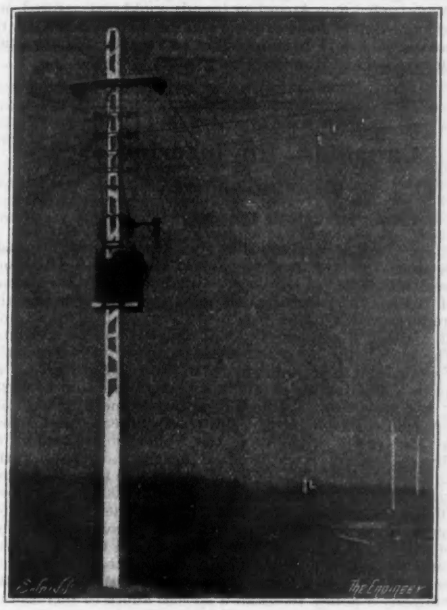


Fig. 6—Terminal Concrete Pole with Transformer

Tariffs have been framed to attract all classes of people, such as ordinary power users, farmers, and domestic and business consumers. For power demands above 5 horse-power there is a flat rate tariff of 1½d. per unit, while private residences and hotels can adopt a two-part tariff in which the fixed charge is 20 per cent. of the rateable value of the premises and the running charge 1d. per unit for all units consumed. For an "off peak" water heating load the price is only ½d. per unit. At present the company's output is approximately three million units per annum with an average maximum demand around 900 kW, produced mainly by the Alpha Cement Company, Ltd., and Carbo Products, Ltd., but domestic and small power consumers are being connected to the system at a very encouraging rate. Consumers' premises are wired, when necessary, on hire purchase terms, the actual work being undertaken by local contractors approved by the company, which specifies how the work shall be done. The wiring system generally employed is the Johnson and Phillips surface system, in which tough rubber sheathed cables are employed. Under the assisted wiring scheme payment for the installation is extended over a period of three years and is made through the medium of slot meters calibrated so that a small charge towards the cost of the wiring is added to the normal cost per unit consumed. The scheme is generally limited to the smaller types of properties, on which it has proved distinctly helpful.

Apart from this assisted wiring scheme the company offers very attractive terms to its consumers for the hire of domestic electrical apparatus, such as cookers, fires, water heaters, wash boilers, &c. Cookers may be hired for as low a charge as 5s. per quarter, water heaters from 4s. upwards, and fires from 2s. 3d. per quarter. A hire purchase scheme for electrical apparatus is at present under consideration. At 80, High-street, Lewes, there is an attractive showroom, in which all the latest electrical devices are to be seen and advice is given to potential consumers.

During a visit to the area last week we inspected several of the largest consumers' premises, including those of the Alpha Cement Company, Ltd. (formerly Cement Industries, Rodwell, near Lewes), and the Glyndebourne Festival Opera House, which will be opened next spring or summer. Glyndebourne is a Tudor house situated in the midst of beautiful country, and the addition of the Opera House gives it new artistic interest. The stage mechanism consists of over seventy overhead sets, two stage lifts, stage wagons, and electrically operated steam-raising apparatus for stage effects, while a newly designed mechanism, said to be hitherto unknown in England, has been installed for operating the proscenium curtain. The stage lighting system, which is considered to be the most modern in the world, is controlled from a special cabinet facing the stage, for which there are seventy spot lights under separate dimming control. Other important consumers are the East Sussex Agricultural Institute, Plumpton, and Plumpton Place, the residence of Mr. Edward Hudson. The consulting engineer to the Ringmer and district electricity undertaking is Mr. W. O. Rooper.

The Gasification of Town's Refuse.

FOR some time the Corporation of Burnley has had under test at its destructor station a new type of plant made by Whitfield Gas Producers, Ltd., 82, Victoria-street, London, S.W.1, which we had an opportunity of inspecting in operation recently. Actually, we understand, the plant is dealing with about one-third of the town's refuse, and the gas resulting is being used for raising steam in a Lancashire boiler. At Burnley the Corporation's electricity generating station is adjacent to the destructor station, and consideration is being given to the production of electrical energy by gas engines supplied with gas from the Whitfield plant subject to the permission of the Electricity Commissioners and the Ministry of Health.

The Whitfield producer, of which we give a sectional illustration in Fig. 1, embraces new features which have been introduced to obviate the troubles which have been met with in the past in dealing with domestic refuse. One of these troubles is the variability in size, character, and density of the material which makes it difficult to distribute the air for combustion uniformly through the refuse in the combustion zone. This feature results in the air taking the line of least resistance through the fuel bed, developing excessive combustion at this spot and forming a "chimney" in the fuel bed; localising combustion and forming clinker in the body of fuel. Other disadvantages which have been encountered are the raising of the zone of high temperature, the air escaping through which causes the burning of some of the producer gas as formed, giving high CO_2 and low CO contents. In this manner, also, the gas formed is hot and cooling results in thermal losses. Further, tar is more liable to be entrained in the gas leaving the producer at a high temperature, and this fact gives rise to tar troubles.

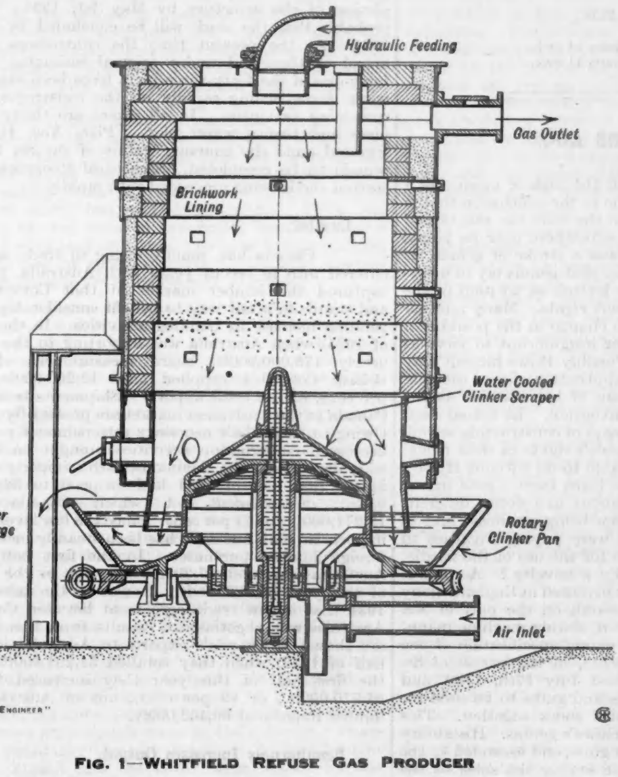


Fig. 1—Whitfield Refuse Gas Producer

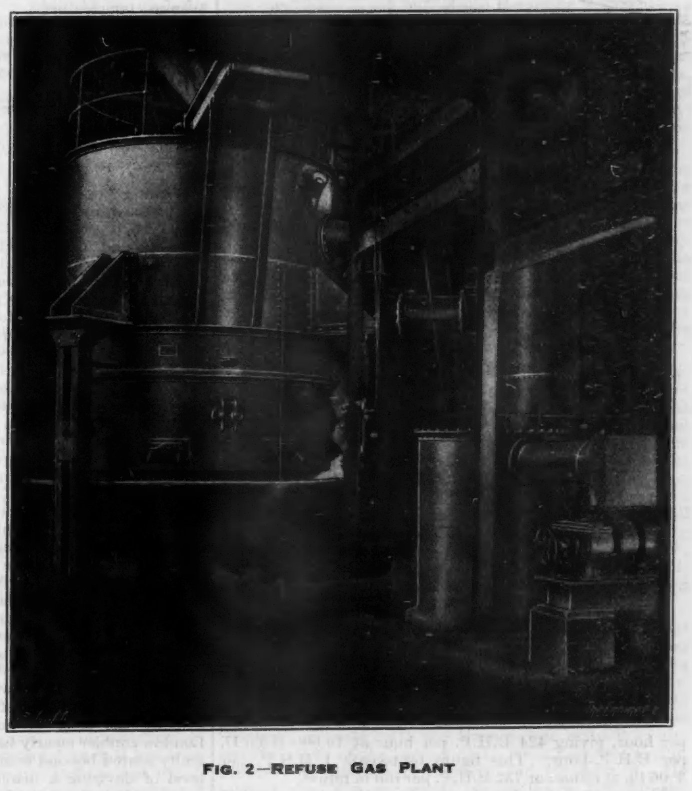


Fig. 2—Refuse Gas Plant

In the Whitfield producer the chief improvement consists in a system wherein the air supplied at low pressure to support combustion is restricted over the whole grate area and meets a uniform resistance in passing through the grate before coming into contact with the bed of fuel. The grate, see Fig. 4, is divided into small sections, and air is distributed over its entire surface, so that each section has an equal amount of air, no matter what may be the condition of the fuel bed above. The grate, as will be gathered from the detail drawing reproduced herewith, is composed of a series of truncated cones of diminishing diameter piled one on top of another. These cones are held together by bolts or studs. On the underside of each pads are formed, the space between these pads constituting expanding orifices from which the air issues. By this means equal distribution of air is claimed to be effected throughout, and no excess air can find its way above the normal combustion zone, thereby restricting combustion to the layer immediately above the grate where the clinker forms and whence it is most easily removed. Another point which the makers claim for this producer is that a reduced depth of fuel bed can be used, and thus less suction or pressure is required, while the confinement of the fuel bed to a low level results in the upper portion of the producer being cooler and giving a lower temperature of gas and in the retention of more tar in the producer, which is condensed in the new fuel on top of the bed. The other important feature is the absence of excess air in the higher parts of the bed, which prevents the burning of the gas in the producer.

As will be observed from the sectional drawing, the conical grate is mounted in the clinker pan, which holds the water seal. The body of the circular generator, which, in the Burnley plant, is 8ft. diameter, terminates below the water level in the pan, and is supported from outside stanchions. The body is water-jacketed to a height immediately above the combustion zone. The pan and grate are caused to revolve slowly by means of a worm reduction gear engaging a large worm wheel attached to the underside of the pan, the speed being variable between one revolution per hour and one revolution in four hours. In the Burnley plant power for this purpose is supplied by a ½ horse-power electric motor. The air which is passed through the grate is provided by a small fan, and is saturated with steam which can be obtained from the water jacket, but which, in the Burnley plant, is supplied from the existing destructor boilers. The refuse is fed into the producer through the hopper at the top by means of a square hydraulic ram, which also acts as a gas seal, and the gas outlet is at the side immediately below the ram feed. The clinker which is formed on the grate is scraped off by means of arms immediately above the grate as the latter revolves, and then passes down into the pan. A plough fixed to a supporting stanchion and carried down into the pan evacuates the clinker as the pan revolves.

The gas, on leaving the producer, passes through primary and secondary coolers, Figs. 2 and 3, to a tar extractor, where the last traces of tar are eliminated. A sample of the gas taken by the Borough Analyst gave the following analysis :—

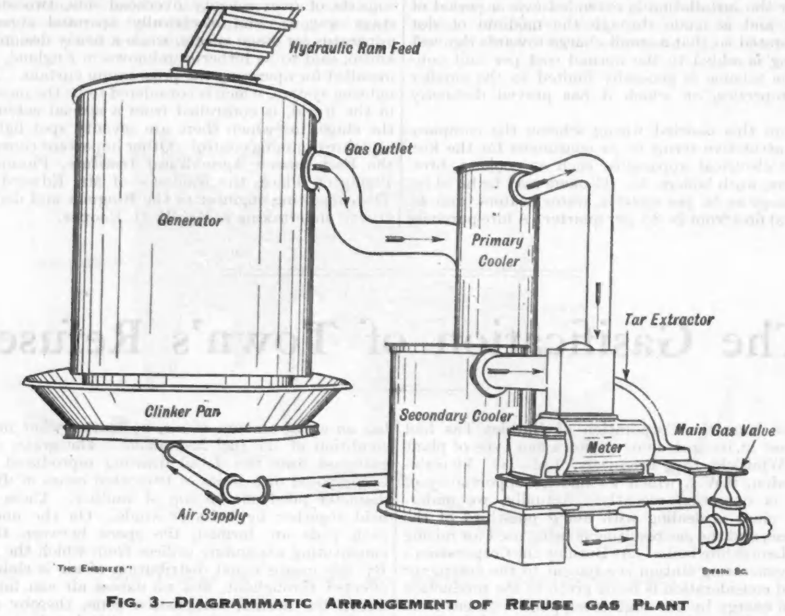


FIG. 3—DIAGRAMMATIC ARRANGEMENT OF REFUSE GAS PLANT

	Per cent. by volume.
Carbon dioxide	10·2
Oxygen	0·4
Nitrogen	48·2
Carbon monoxide and hydrogen	40·0
Hydro-carbons	1·2
Total	100·0

The results of tests carried out by the Burnley Corporation Cleansing Department are given in another table below. The figures show an average gas yield per hour of 32,100 cubic feet from an average feed of 11·6 cwt. per hour, giving 424 B.H.P. per hour at 10,000 B.Th.U. per B.H.P.-hour. This figure represents 1 B.H.P. per 3·06 lb. of refuse, or 732 B.H.P. per ton of refuse.

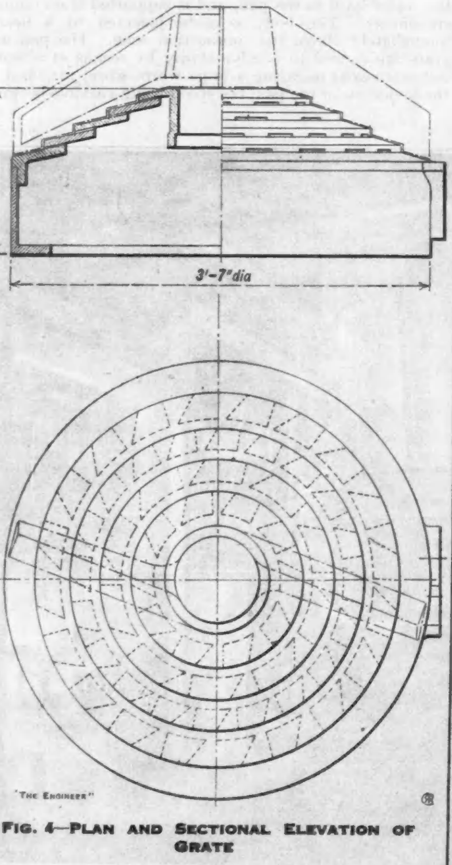


FIG. 4—PLAN AND SECTIONAL ELEVATION OF GRATE

The report states that the quality of the screened refuse was very poor, as it contained a large amount of paper. It also states that the dust had been removed by passing the refuse through a screen of ⅜in. mesh and that the refuse was fed into the generator by hand.

Mr. Arthur Race, the Borough Engineer and Surveyor, estimates that a plant of this description large enough to deal with the whole of the refuse of Burnley would cost £34,000, and would cost the Corporation £6277 annually for interest, working cost, maintenance, overhead expenses, and the removal of dust and clinkers. Against this he estimates a production of 605,000,000 cubic feet of gas per year, 2,000,000 cubic feet of which would be used for the incineration of offal refuse, leaving 603,000,000 cubic feet of an average calorific value of 125 B.Th.U. per cubic foot. The horse-power-hours available on a basis of 10,000 B.Th.U. per horse-power-hour would be 7,537,500. The units of electricity generated, with a generator efficiency of 90 per cent., would be about 5,000,000 per annum. Assuming that 0·15d. per unit is realised for the gas supplied to the electricity undertaking, the annual revenue would be £3125, and therefore the cost of refuse disposal would be £3152 per annum, or 2s. 10½d. per ton. No allowance has here been made for possible revenue from the clinker or separated dust, metals, &c.

Test Results.

Period of test	Commencing 11 a.m. Monday, June 26th, 1933, continuously until 11 p.m. Friday, June 30th Saturday, July 1st, 8 a.m. to 11 p.m. Monday, July 3rd, 8 a.m. to 11 p.m. Tuesday, July 4th, 7.30 a.m. to 11 p.m. Wednesday, July 5th, 8 a.m. to 11 p.m.
Total weight of refuse dealt with	97 tons 18 cwt. 2 qrs.
Total quantity of gas produced	5,409,900 cubic feet
Total number of hours worked	168¼
Average calorific value of gas (from calorgraph chart)	132·1 B.Th.U. per cubic foot (gross)
Average temperature of gas at outlet ..	85·6 deg. Fah.
Weight of clinker removed from plant ..	Wet—63 tons 14 cwt. Dry—45 tons 11 cwt.

SIXTY YEARS AGO.

When Elias Howe set himself the task of producing a sewing machine he speedily came to the conclusion that it would be necessary to transfer the hole for the thread from the end of the needle to somewhere near its point. This departure from tradition was a stroke of genius, or perhaps it would be better to say that genius lay in incorporating this apparently minor feature as an item in the subsequent application for patent rights. Many another man might have considered the change in the position of the needle eye as too obvious or insignificant to serve as the basis of a specific claim. Possibly Howe himself may have included it in his patent application almost casually and looked upon the mechanism of his machine as the really important part of his invention. In actual fact, however, there were dozens of ways of constructing sewing machines without infringing Howe's rights in their mechanical details, but no one was able to do without Howe's needle. Sixty years ago, as we learn from a note in our issue of October 17th, 1873, about five dozen different varieties of sewing machine were being produced and in every case the manufacturers were paying royalties to the trustees of the Howe estate for the use of the needle. But was the Howe needle really a novelty ? A rumour began to spread that it had been invented in England many years previously. Diligent research on the part of Mr. Lucius Lyon, of Finkle and Lyon, sewing machine manufacturers, brought to light the patent specification of one Thomas Saint, of Greenhill Rents, in the parish of St. Stephen, London. It was dated July 17th, 1790, and covered a composition of resins and gums to be used for sticking the soles of boots and shoes together. This London cobbler clearly lacked Howe's genius. His ability really soared beyond resins and gums and ascended to the level of devising a machine for sewing the soles to the uppers. It had a spool for the thread, an awl to make the holes in the material, and a needle to drive the thread through the hole, and the eye of this needle was at the point precisely as in the Howe machine. A drawing of the machine—and for that matter a drawing of a weaving machine and several other appliances—accompanied Saint's specification of 1790, but the textual portion was devoted entirely to the resin and gum compound. Not a word was said about the machinery illustrated by the drawings. Hopes were at once raised by the discovery of this old specification. Some held that it would put an end to the payment of royalties to the Howe estate. Others went further and talked about recovering the enormous sums which had been paid in past years by way of royalty. We ourselves took the trouble to examine Saint's specification. We found it to contain "a most unintelligible drawing" of a sewing machine of apparently the crotchet stitch type. Our American friends could rest assured, we added, that even if Howe's patent were proved to be invalid it would be impossible to recover the royalties already paid to Howe and his trustees.

Canadian Engineering News.

(By our Canadian Correspondent.)

British Exhibits in Canada.

As a medium for the development of trade between the various countries of the British Commonwealth of Nations, the work carried on by the Federation of British Industries in enlarging and strengthening the trade ties of Empire, was well illustrated in its exhibit at Canada's annual National Exhibition, at Toronto. The recent display marked the tenth anniversary of the Federation's first appearance in Toronto. Starting as quite a small affair of about twenty exhibitors in 1923, it has grown until it now comprises some fifty exhibits covering between twenty and thirty different industries. At the recent Exhibition the Federation's exhibit of British manufactures occupied nearly the whole of the north and south wings of what is known as the old Government Building, covering an area of 17,000 square feet. Of all the British exhibits there was one that calls for special mention—the motor truck travelling exhibit of Sir W. G. Armstrong, Whitworth and Co., Ltd. The company's truck contained a complete collection of pneumatic tools sent to Canada in furtherance of the company's policy to make a special effort to increase its trade with the Dominion. The samples shown at Toronto were chosen with a view to their suitability for North American requirements, just as the five similar motor trucks now touring elsewhere carry tools applicable to local requirements. One of the great advantages of the work of the Federation of British Industries in staging an annual exhibit at Toronto lies in the assistance it gives to British firms new to Canadian markets. The last ten years have proved that for newcomers an exhibit at Toronto saves a great amount of exploration work. By arranging test displays they are able to ascertain the reaction of the Canadian people to various classes of goods and can judge in the quickest possible time how acceptable, or otherwise, their products may be to Canadian buyers. Another important feature of the British display is the private view each year held on the afternoon before the public opening of the Exhibition. This has become an occasion of some consequence in Toronto, and is attended by upwards of 2000 guests, all of whom are directly interested from a commercial point of view in the various goods displayed.

Progress of St. Lawrence Bridge.

The 3,000,000-dollar bridge spanning the St. Lawrence River between Caughnawaga and Ville La Salle, which is being erected by the Lake St. Louis Bridge Corporation, will, in all probability, be completed approximately a year ahead of schedule. Plans called for completion of the structure by May 1st, 1935; but it is probable that the work will be concluded by July 1st, 1934. At the present time the contractors are both ahead of time and under original estimates. Already forty-one of the forty-three piers have been erected, and work is proceeding rapidly on the construction of the remaining two piers. In all, there are thirty-one land piers and twelve water piers. Piers Nos. 11 and 12, situated amid the coursing waters of the St. Lawrence, remain to be completed. Structural steelwork has also started and is being proceeded with rapidly.

Lumber.

Canada has, mainly owing to trade agreements entered into in recent years with Australia, practically captured the lumber market of that Commonwealth, and stands in a fair way to benefit considerably from the pending increase in building activities. In the first half of 1925, when Australia was importing to the extent of nearly 173,000,000ft. board measurement of lumber, British Columbia supplied only 12,200,000ft., or 7·6 per cent. of the total imports. Shipments from Eastern Canada to the Australian market are practically negligible. Owing to Australia's necessary retrenchment policies and decreased construction activities brought on by world-wide depression, the Commonwealth's imports of lumber in the first half of 1931 had dropped to 32,320,000ft. board measurement, of which Canada supplied 13,271,000ft., or 41 per cent. Since the low level of lumber imports in 1931 Australia has been steadily increasing her foreign lumber purchases. In the first half of 1932, Australia imported 57,398,000ft., and in the first half of this year 69,402,000ft. It was in the latter part of 1931 that a new trade agreement between Canada and Australia was negotiated. Results from this agreement are shown in Canada's exports to Australia in the first half of 1932, when they totalled 51,291,000ft., and for the first half of this year they increased further to 64,770,000ft., or 88 per cent., out of Australia's total lumber imports of 69,402,000ft.

Beauharnois Increases Output.

The power output of the Beauharnois Power Corporation has been increased from 60,000 to 133,000 H.P. Of this additional power the Ontario Hydro-Electric Power Commission has taken 40,000 H.P., and the Montreal Light, Heat and Power Consolidated 25,000 H.P. The balance of 8000 H.P. is taken by Montreal Cottons. The company's contracts call for the eventual delivery of 462,000 H.P.

Railway and Road Matters.

The tessellated pavement, now known as the Checkon Pedestrian Safety Crossing, mentioned herein on August 18th as having first been used in Salford, is being laid down in Leytonstone, Croydon, and Brixton.

Some 15,000 employees of the L.M.S. Railway will be attending special classes and lecture courses this winter in accordance with the company's policy of providing free educational facilities for many grades of its staff.

The "Royal Scot," the L.M.S. Railway's complete express train which is now on exhibition at the Century of Progress Exhibition at Chicago, is to make a further extended tour of Canada and the United States during the autumn.

The Railway Operating Medal and the Railway Engineering Medal, given by the Railway Companies' Association for inclusion in the awards made by the Institute of Transport, have been won by Mr. E. D. Grasett and Mr. F. Lydall respectively. The paper read by the former was on "Freight Train Operation," whilst Mr. Lydall dealt with British Main Line Electrification. The medals were presented by the President, Mr. W. Whitelaw, at the opening meeting on Monday, October 9th.

The worst train accident on the railways of Ireland was the Armagh disaster of June 12th, 1889, when eighty passengers were killed. The next most serious accident in Ireland occurred eighty years ago. It occurred at Straffan, Great Southern and Western Railway, on October 5th, 1853, and was due to a collision between a passenger train and one conveying cattle. Fifteen passengers were killed, and it was the most serious accident on the railways of the United Kingdom up to that time, and remained so until the collision of August 25th, 1861, in Clayton Tunnel, when twenty-three passengers lost their lives.

The publication of an agreement made between the railway companies and the proprietors of privately owned rolling stock as to the charge for the transit of their empty wagons, shows that there are 526,000 such wagons. Of these, 373,000 belong to collieries, coal merchants, coal factors, &c.; 125,000 mineral wagons, and 500 tank wagons are the property of wagon-hiring companies; 16,000 are used for ironstone, gravel, brick, lime, cement, &c.; and 11,500 are tank wagons owned by oil companies. The agreement in question is the result of prolonged discussions between the companies and a committee of traders as to the interpretation to be put upon the entry in the General Classification as to rolling stock regulations. Instead of paying separate charges for individual wagons, the traders are to make a collective payment of £21,000 a year; originally, the railway companies estimated their gross annual receipts from charges paid for the haulage of empty privately owned wagons to be upwards of £37,500.

The Raynes Park, Southern Railway, derailment, and the subsequent collision with the derailed coaches, of May 25th, when five passengers were killed by the collision, has revealed a weakness in the railway companies' standard rules as to engineering work that affect the safety of the track. It may be remembered that as a passenger train was running between Wimbledon and Raynes Park on the down through line the engine and its five eight-wheeled vehicles were derailed. Some of the coaches fouled the adjoining up through line and were struck by an up passenger train. As part of a programme of improvements the long curve that begins at Wimbledon was having its radius at this point increased from a minimum of 64 chains to one of 80 chains. That was done on the preceding week-end, and the work in hand at the time of derailment was "to top and fettle the high rail of the curve, and to correct the superelevation where necessary." That had to be done between trains, and, when the down train approached, a lift of at least 1¾in., and possibly more, was in hand, but the time available proved insufficient to pack all the eleven or twelve sleepers, and the track was thus temporarily defective. Colonel Anderson concludes his report on this accident by saying that it illustrates the need for the greatest caution when any such work on the track is carried out under fast and dense traffic. While the height of a lift has hitherto apparently been taken as a criterion of what may or may not be done without possession of the line or speed restriction, the time interval between trains appears to be equally important.

The fatal collision of June 17th between a double-headed express and a mineral train at Crich Junction, Ambergate, London, Midland and Scottish Railway, mentioned herein on June 23rd, was inquired into by Colonel Trench, whose report was issued on October 5th. As both drivers were killed and their firemen were unable to throw any light on the condition of the signals, there is only the evidence of the signalman concerned to support the conclusion that the express ignored the distant, inner home, and starting signals at Wingfield. All the facts, moreover, point to that having been done, and it thus becomes a question as to how such men, of whom it is said that they "had good records and were considered sound passenger express drivers," came to be so remiss in their duty. In this connection we would refer to a paragraph which appeared in this column on September 1st last, wherein we suggested that the driver who was found responsible for the Ais Gill collision was misled by the signalman not fully acting up to a rule which provides that when a starting signal is at "danger," the home signal must be kept "on" until the train has been brought quite, or nearly, to a stand. At Wingfield, as at Ais Gill, the home signal was put to "clear" prematurely, and the drivers would therefore naturally assume that the other stop signals were in their favour. There is also the possibility that the distant at Wingfield might have been missed and the home signal taken for the distant. Colonel Trench recommends therefore that if the companies cannot see their way to delete the words "or nearly," they should see that the "nearly to a stand" should be rigidly obeyed. He points out that the accident was one which would have been prevented by automatic train control, and that it showed the value of the detonator placers which were now being provided in new and reconstructed signalling installations.

Notes and Memoranda.

The imports of electrical machinery, apparatus, and cognate material into Italy during the five months ended with May last attained a value of £663,365, as compared with £929,110 in the corresponding five months of 1932. There was also a decline during the same period in the exports of similar material from Italy from £768,730 to £294,540.

The uses of tin are analysed in a survey prepared by the International Tin Research and Development Council in London. Amongst the uses mentioned are those connected with the electrical industry, such as the manufacture of wires, wireless parts, lighting fixtures, refrigerator coils, solders, cable sheathing, lampshades, &c., and (in the form of tinfoil) in electrical condensers.

The Soviet stratosphere balloon, the "U.S.S.R.," made a second ascent into the air on Saturday, September 30th, and reached an altitude of nearly 12 miles. The balloon was in the air for 8 h. 15 min., and important scientific observations were made. According to later reports, it is now believed to have gone higher than the 12 miles originally recorded on Saturday. A special commission of scientists is checking the instruments and calculating the maximum height from data taken at land observation points. Meanwhile, the possibility of making further flights throughout the winter months is being discussed.

It is with regret that we have to record the death on Tuesday, October 10th, of Mr. Joseph P. Wolfe, formerly the chief engineer of the White Star liner "Majestic." Mr. Wolfe was born in Liverpool and educated in London, where he served his apprenticeship with the Thames Ironworks, and afterwards with Laird Brothers, of Birkenhead. He began his sea-going career with Lamport and Holt, Ltd., and transferred to the American Line in 1894, later going to the White Star Line, in which he served as chief engineer in many of the largest liners. At the end of the war Mr. Wolfe was sent by the White Star Line to Germany to superintend the completion of the "Homeric" and "Majestic" prior to these liners being handed over. Later he took over the post of chief engineer of the "Majestic," and remained with her from that time until indisposition caused him to relinquish his post in October, 1930.

The correct way to fit a stud depends, says Mr. E. S. T. Hill, in the *American Machinist*, on what the stud has to do. A parallel thread may not hold unless bottomed. It can only be made to hold by deforming the threads. It seems better not to bottom, but to deform the unthreaded portion of the stud. Hence it is wrong to make the stud with a collar strong enough to allow thread deformation. If the stud is not asked to stand a big stress, use parallel threads, tight if desired, but do not deform them. Obviously, it is waste to make a screw and then to destroy it. For heavy duty, a taper thread is to be preferred, as it enables a real jamb to be effected without spoiling the screw. But in most of the instances where studs are used the duty is heavy and a stud is not good practice. It is doubtful whether a machine exists after a few years of use in which the studs have not given trouble to the millwright. Bolts, rivets, and pins are often better engineering and better for the repairer.

The lithopone manufacturing industry was founded and first developed in this country by Mr. John Bryson Orr, who recently died at the age of ninety-four. He lived long enough to see, under the stimulus of the new fiscal policy, a marked revival in the manufacturing industry. Despite the introduction of newer white pigments, lithopone seems destined to maintain its position in the paint, rubber, linoleum, and other industries. The reaction whereby a pigment consisting of barium sulphate combined with zinc sulphide is produced by the double decomposition of solutions of zinc sulphate and barium sulphide has been described as one of the most remarkable reactions in industrial chemistry. Orr's invention, whereby the pigmentary properties are developed by igniting the precipitate to redness in the absence of air, discharging the red-hot mass into cold water and thoroughly grinding whilst wet, laid the real foundations of the modern lithopone industry.

An interim report of the Inter-Departmental Home-grown Timber Committee, 1933, issued by the Stationery Office, contains short references to the use of larch, Scots pine and other timbers for power transmission line, telegraph and telephone poles. As a result of evidence given by the Electricity Commission, Central Electricity Board, and Overhead Lines Association, the B.S.I. has under consideration a specification for larch poles for use in transmission lines. The Institution is collecting cost data and going into the economics of the matter; the Forests Products Research Laboratory is testing for strength and securing evidence of durability. Home-grown Scots pine poles of a minimum size of 16ft. long and 6in. in diameter at the butt are accepted for telephone poles by the Post Office. At the request of the Committee, the Forests Products Research Laboratory is testing Corsican pine, Norway spruce and Sitka spruce for strength and capacity for absorption of preservatives. If the tests show that these timbers compare favourably with Scots pine, the Post Office will give them an endurance test.

The use of super-hard materials for tipping tools has, says *Machinery*, increased, for the advantages resulting from their employment in various machining operations has been abundantly demonstrated. Many of them consist essentially of tungsten carbides bonded with or alloyed with different metals. Some of them are produced by sintering powders and others are melted and cast. The application of these materials has been successfully extended in many cases to the manufacture of drawing dies and many alloys are marketed under various trade names. One of the most recent developments in the field has been the production of cemented tantalum carbide dies which are claimed to compare very favourably with cemented tungsten carbide under similar conditions of test. A method has been perfected in America of mounting tantalum carbide tips by brazing an inset of pure molybdenum between it and the steel shank. Since molybdenum has almost the same coefficient of thermal expansion as tantalum carbide alloys, its use prevents strains being set up or cracks developing in the tips after brazing.

Miscellanea.

The zinc oxide plant of the Sulphide Corporation at Seaton Carew is being extended on account of the increased demand, both at home and abroad.

It is said that an ample supply of potable water for Rangoon has been discovered, and that the cost of its development will not be prohibitive.

The high-level sluices of the Mettur dam, in Southern India, were opened for the first time about the middle of September and the water turned into the canals.

It has been found necessary to postpone the reception by the President of the Institution of Chemical Engineers from November 16th to Wednesday, November 22nd.

The United Provinces of India Government proposes to organise a scheme for the production of motor spirit from alcohol with the idea of stabilising the sugar industry.

Owing to prevailing trade conditions, the Textile Machinery and Accessories Exhibition, which was to have been held in Bradford, Yorkshire, from October 11th to 21st, has been indefinitely postponed.

It appears that the consumption of electricity in the area of the West Midlands Joint Electricity Authority has increased by 11·3 per cent. during the last six months. The greatest rate of increase has come from industrial centres.

The Cardiff Waterworks Committee has decided to expend £40,000 in developing a water supply from the lower catchment area at Llwyn-on, in the Brecon Beacons, which will give the city an additional daily supply of 4,000,000 gallons.

On Saturday, September 30th last, an interesting event took place in the social life of the works of Thompson Bros. (Bilston), Ltd., in the form of the opening of the company's new recreation ground for employees, by the Charter Mayor of Bilston, Councillor H. Beach, J.P.

Among the proposals of the Dutch Government for the relief of unemployment is one which suggests the improvement of the Merwede canal connecting Amsterdam and the Rhine. The scheme will cost about one-third of a million sterling and involves a canal with a width of 164ft. and only one lock.

Nearly 200ft. of dyke protecting the north coast of the Island of Beveland, on the Eastern Scheldt, about 20 miles north-east of Flushing, suddenly sank on Wednesday to below the normal level of the land. The breakdown exposed the fruit farms in the neighbourhood to flooding with the rise of the tide, and it is feared that very great damage may be caused to orchards near the shore. Fortunately, the danger is considerably reduced by the fact that a second or inner dyke stands about 50 yards inland.

The question of utilising the sun's energy has in recent years been attracting the attention of scientists and engineers. Now we learn that a Russian has invented a solar kitchen. It has been constructed by Mr. Poshtar, a member of the helio station in Samarkand. He recently tested his apparatus in the presence of scientists and technicians and representatives of Soviet public life, and the *Pravda Vostoka* reports that meat soup was cooked on the solar kitchen range in two hours, and that kashba (a kind of porridge made of buckwheat) with meat took fifty minutes to cook.

Since the Royal Charter was granted to the Institute of Marine Engineers in March last an important alteration has been made in the regulations governing the admission of students. A detailed syllabus of the student examination has been issued, with particulars of exemptions open to candidates possessing certain educational qualifications. The next examination will be held in May, 1934, at various centres, according to the candidates' places of residence. Full particulars may be obtained on application to the Secretary, the Institute of Marine Engineers, The Minories, London, E.C.3.

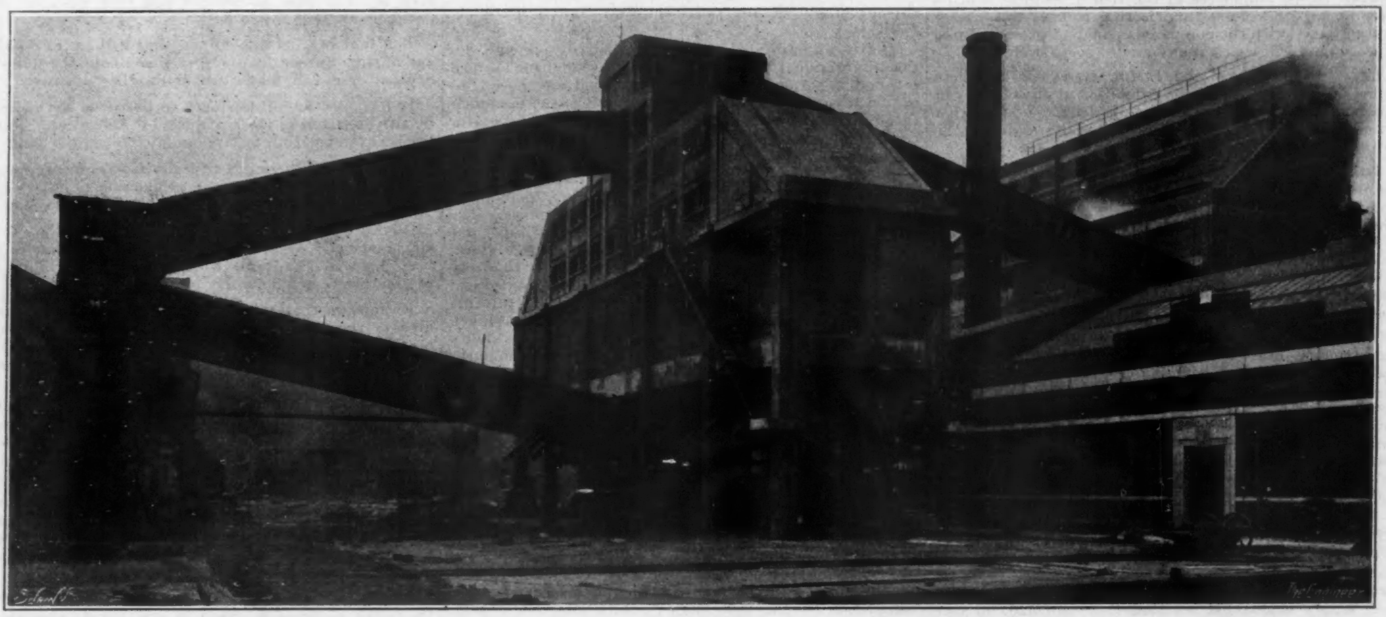
It is understood, says the *Iron and Coal Trades Review*, that, in connection with the scheme for establishing a coal-distillation factory near Irvine, Ayrshire, a new company is being formed, to be known as Charles Turner (Scotland), with a capital of £1,000,000. The company is to acquire from the vendor, Turner Trust, Ltd., the sole and exclusive licence to use the Turner patent and process in Scotland. In order to ensure adequate supplies of suitable coal the company propose to acquire two collieries—the Mauchline colliery in Ayrshire, and the Auchlochan colliery in Lanarkshire.

On Wednesday, October 4th, the Hon. Oliver Stanley, the Minister of Transport, in company with Members of Parliament, inspected the million-pound improvement scheme now being carried out by the Grand Union Canal Company. When the work is finished, along the whole of the route from London to Birmingham canal banks will have been concreted; canal locks will have been widened from 7ft. to 12ft. 6in.; loads up to 100 tons will have been made possible; and horse-drawn boats will be largely replaced by motor-driven models. Over fifty new locks are being built during the course of the work, many of them by the side of others over 100 years old. A feature of the scheme is that not once has it been necessary to suspend the through traffic.

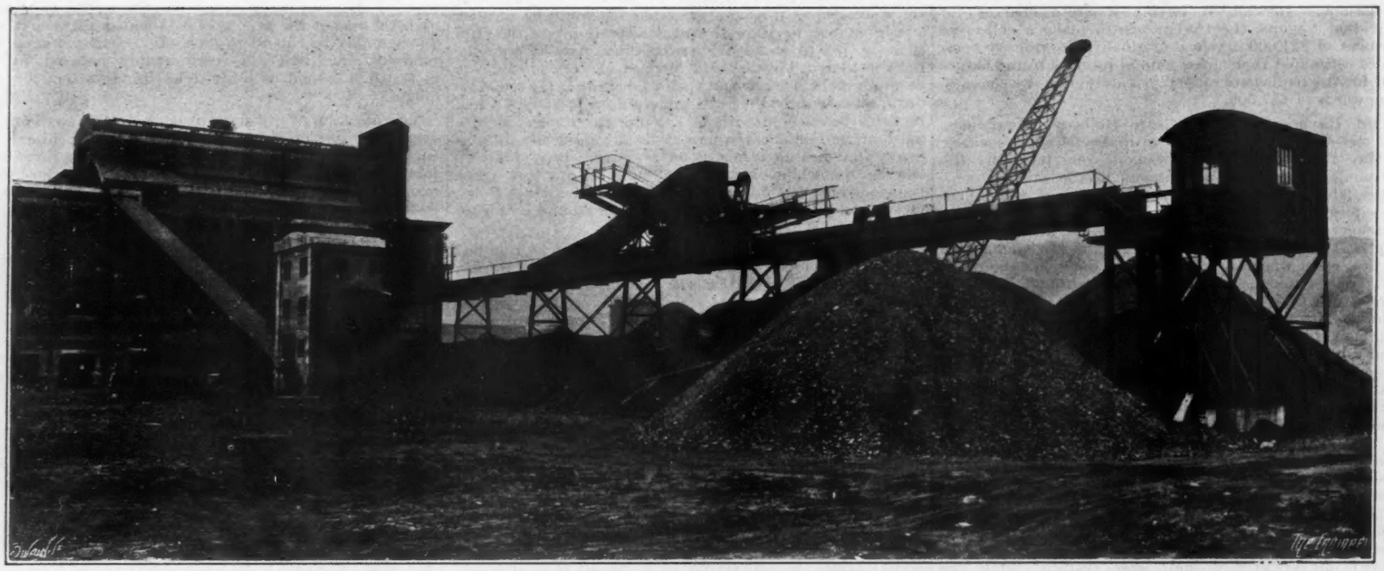
At a conference held at Buckie on Saturday, September 30th, it was stated that in 1924 the Buckie Fleet comprised 285 steam drifters. This was reduced to 241 five years later, and the number was becoming less every year. Seventy per cent. of the drifters were over twenty-five years old. Sir Godfrey Collins, the Secretary of State for Scotland, in reply, said the Government realised to the full the plight of the herring fleet. That fleet was a vital necessity to the fishing industry and for defence. He realised that the arguments placed before him for the modernising of the herring fleet deserved the most careful consideration. He could assure them that the matter would be looked into. Sir Godfrey afterwards inspected a large motor-drifter under construction in the building yard of Messrs. Thomson and Stewart, Buckie, a type which is expected to prove the successor of the steam drifter.

THE HIGGINSHAW GASWORKS OF OLDHAM CORPORATION

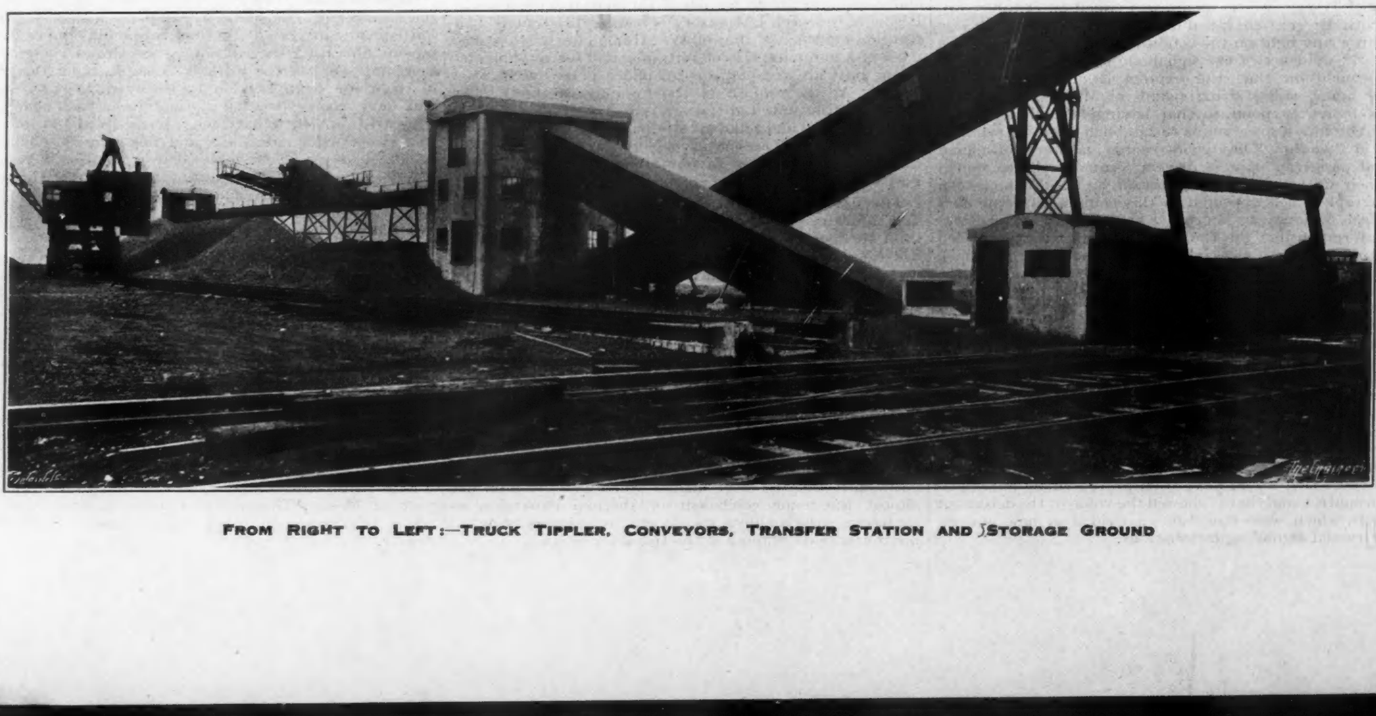
(For description see page 348.)



From Right to Left:—Engine House (Retort House behind), Screening Plant and Skip Station



From Right to Left:—Stock-Pile Conveyor, Transfer Station and Retort House



From Right to Left:—Truck Tippler, Conveyors, Transfer Station and Storage Ground

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NOTICES TO READERS.

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A RAILWAY CHAIRMAN'S ADDRESS.

The new President of the Institute of Transport is Mr. William Whitelaw, the Chairman, since its constitution in 1922, of the London and North-Eastern Railway and previously the chairman of the then North British and, earlier still, of the Highland. In the inaugural address which he delivered on Monday evening last, Mr. Whitelaw mentioned, in his opening remarks, that he had been a director for thirty-five years, during thirty-two of which he had borne the responsibility of the chairmanship. Such a lengthy service in so high an office might give to those who do not know him a wrong impression of Mr. Whitelaw's age, but we can assure them that, when, in relating an event in the year 1901, he speaks of himself as "a young enthusiast," he was aptly describing himself as he was at that period. We may add that, though he is now more than thirty years older, he still retains his former enthusiasm. In that year, as he recalled in his address, he proposed the acquisition of the Highland Railway by the Caledonian and the London and North-Western. He told the late Mr. C. H. Mason, the solicitor to the latter company, that the Highland would soon be earning a dividend on its ordinary stock. Mr. Mason replied that if he was convinced that even 1 per cent. could be earned, he would advise his board in favour of amalgamation, but he added, in the most kindly way, that, while he did not wish to damp the ardour of a young enthusiast, he could not believe that any such dividend could be earned by the Highland. That ended the proposal, but Mr. Whitelaw's prophecy came true; in 1903 the dividend of 1 per cent. was earned and paid, rising gradually to 2½ per cent. in 1913. Had the Highland been absorbed the East Coast companies would doubtless have proposed to purchase the Great North of Scotland Railway and thus a part of the existing amalgamation might have been carried out twenty years before it was accomplished under the Act of 1921, and there would have been none of the controversy, raised by the proposals of Sir Eric Geddes, as to whether the Scottish companies should be united in one group or, as was done, combined with their English allies in parallel lines.

We mention this anecdote as illustrating the ability of the new President to speak, from experience, to the young men of the Institute and particularly to the railway operating men. There is a considerable amount of candour in what he says. His remarks on examinations and their value, particularly his playful suggestion that "fail-ees" should be allowed to set examinations for the examiners, will appeal to many young engineers. Elsewhere he remarks that railway managers engaged in the practical management of their companies would have an easier life "if they were able at times to disregard the theories of the engineer, the kindly autocracy of the accountant, and the restriction imposed by the legal adviser." Mr. Whitelaw then tells a good story of how six-coupled engines were not allowed north of Inverness because their axle load was beyond the limit laid down for that territory. Subsequently it was found that the drivers of the engines in common use had been in the habit of adjusting the axle load so that the weight borne exceeded the limit which the engineer considered was the maximum! Fortunately they did not damage the line. The fallacy of depending upon theory instead of on fact was exposed by an illustration from the amount of track renewed each year on the Highland. Between 1902 and 1909 the average renewal was 10 miles a year, but between 1909 and 1913 it was only about 4 miles a year. Engineers, generally, would not expect such a permanent way to be in very good order, but the war brought a traffic which every month of four years was far in excess of the amount carried in the busiest month of the summer of previous years. Obviously the condition of the permanent way was put to an extremely practical test. Moreover, the line north of Inverness was intended only for the light rolling stock used there, but during the war it had to carry, daily in both directions, the heaviest passenger rolling stock of the London and North-Western Railway. The Highland ceased to have a separate existence in 1923, before which date, with an average renewal of only about 7 miles a year out of a total track mileage of 564, the permanent way should, according to generally accepted theories, have ceased to function. Mr. Whitelaw does not suggest that such a programme of renewal could be applied to railways generally, but the facts just related at least "cause one to think that such a practical test of the endurance of the permanent way is not without its lesson." The question is then asked: Have permanent way engineers made sufficient allowance in estimating the life of their roads for the greater weight of rails and chairs, better fastenings, more efficient creosoting of sleepers, more attention to good drainage, and the greatly extended use of stone ballast in place of gravel or ash? Have they made any allowance for the wonderful improvement in the balancing of locomotives, so that a locomotive weighing 120 tons or more may be much lighter on the road than one of older construction weighing much less? The same thing applies to bridges; "only a few years ago engineers had to condemn girder bridges on mathematics, where to-day their strength can accurately be measured, and fact, by displacing pure theory, has added years of life to many a railway bridge." Mr. Whitelaw daringly suggests that it is possible that, in the past, unnecessary expenditure has been incurred on renewal of the permanent way because its life was estimated wholly upon theory, and that actual inspection and practical testing thereof, to secure reliable facts as to its condition, may well lead to definite savings in that branch of railway expenditure. He does not think too much importance can be attached to the day-to-day maintenance work on a line, and he feels sure that the efficient performance of that work would add very materially to the life of a well-laid road.

The latter part of the address deals mainly with the Railways Act. The principal theory of the Act was that an economic basis for the amalgamated companies would be found by stating the remuneration to which the owners of railway capital should be entitled; and by the appointment of one tribunal to fix wages and conditions of labour, and another to ascertain and fix rates and fares which would, under efficient management, provide the cost of labour and the proper remuneration of capital. "The latter tribunal has, year by year, given the companies its certificate of efficient and economical management, but has found its duty of fixing rates and fares for the proper remuneration of capital, in the face of the cost of labour as fixed by the sister tribunal, to be impossible of discharge. The Act had assumed that there would always be traffic awaiting conveyance at the necessary rates and fares, and Parliament does not seem to have given any consideration to the situation which has actually arisen, in which the traders are clamouring for lower rates and greater rapidity in conveyance, while, even at the existing rates, the economic position aimed at has not nearly been reached. Here, certainly, is an instance of the breakdown of theory before irrefutable facts." In drawing attention to what Mr. Whitelaw has to say about wide decentralisation we recall the objection we raised when grouping was being proposed a dozen or more years ago. We then said that it was out of the question that the authorities at Euston could have the same close acquaintance with local conditions in the Potteries that the North Stafford Railway people had, or that they would have the same knowledge of hematite ore that the Furness Company possessed. Mr. Whitelaw, on the present occasion, says that, even in this small island of ours, there are many important centres of commercial enterprise and, between the North of Scotland and London, railway problems are by no means always similar nor are the requirements of traders always identical. But whatever their differences, there is one thing all traders are unanimous about, and that is that they should be able without undue exertion and difficulty to meet with a man in real authority who has power to come to a definite arrangement in connection with their transport problems, without reference to a head office, situated, it may be, some hundreds of miles away. "The spreading of the responsibility," he says, "becomes more and more necessary as the task increases in volume and complexity, but with adequate decentralisation there seems to be hardly any limit to the size of a company which can be put under one control; it is all a mixture of personal control and wide diffusion of responsibility throughout the geographical area served by the company." He, for one, would have no fear of the unification of all the railways. "Probably it will be said that that would be just the penultimate step to nationalisation. The statesmen of the future will be well advised not to be frightened by a name. National management of the railways would prove," he is satisfied, "ruinous to both passenger and industrial transport, but national ownership, with management completely divorced from political influence, is not impossible and cannot be dismissed from consideration for all time because of the prejudice attached to the name of nationalisation."

On another page we reprint the major part of the address and we feel sure that many engineers will read it with the greatest pleasure. The public, as we know, is all too prone to forget the benefits which the railways confer, and to censure them for defects which are often outside their control. It is of interest now and then to see the railways from a chairman's point of view, and when that chairman has the long experience enjoyed by Mr. Whitelaw and a facility for coming lightly, but directly, to the point he desires to make, his comments are likely to be remembered. To some of his views we have alluded above. Not all of them will be readily accepted, and concerning two, at least, there will be strong differences of opinion—we refer to his remarks on permanent way and nationalisation. If there is one thing more than another of which British railways can justly boast, it is the upkeep of the permanent way, in which we include bridges. Engineers, we believe, have not, in fact, been slow to appreciate the good effect of the reduction of locomotive hammer blow, but it will take a deal of persuasion to induce them to go below the factors of safety which have become traditional. Often it is good economy to be too strong than even a little too weak. On the question of nationalisation we can only say here that if the word has become ominous it is because a certain school of thought has made it so. Probably the railways themselves would have no objection to nationalisation—for a due consideration—but it will always be opposed by those who fear that it would be but one more step towards the nationalisation of everything and the supersession of the individual.

Waste.

Under the heading "Waste in Manufacture," we gave, in our last issue, a few extracts from the Presidential Address which Mr. Engelbach delivered to the Institution of Automobile Engineers in London. No one who reads it can fail to be struck by the remarkable figures, taken from the records of a great motor-manufacturing firm, which it presents. It is recognised that the methods employed in the making of cars are the most advanced to be found in the whole realm of mechanical engineering. Yet a leader of the industry was able to show that out of all the materials used only 26 per cent. by weight was to be found in the finished product. Whilst in the case of paint, of which part is admittedly volatile, no more than 2 lb. weight out of the 22 lb. consumed is left on each car body. It might be assumed that in motor car factories at least there was little or no waste beyond that which was inevitable, but Mr. Engelbach told his audience that he himself was so appalled by the figures when he came to collect them for the preparation of his address that he caused investigations to be made, and that they had resulted in considerable reductions.

Whilst the figures put forward by Mr. Engelbach must inevitably cause not only heart searchings, but searchings of a material kind in manufacturing works, and whilst we anticipate that they will increase the acceleration of the engineer's never-ending pursuit for greater efficiency, we fear that in the hands of the partly informed an unjust whip may be made of them for the chastisement of manufacturers. All is not waste that so appears. When Mr. Engelbach states that "in order to produce 170 tons of finished castings 1000 tons of iron ore, 600 tons of coal, and 200 tons of limestone, a total of 1800 tons, have been used," he presents a case which is only appalling because it omits certain facts. The thousand tons of ironstone may contain less than 25 per cent. of iron; but the 600 tons of coal and the 200 tons of limestone have to operate on almost the whole bulk of the ore in the smelting furnace. If Providence had presented man with sufficient meteoric iron to meet all his needs, the expenditure of fuel and flux on the smelting operation would be reduced to negligible proportions. We may perhaps compare the waste that goes on in the production of pig iron, and in many other operations, to the waste of heat in a steam engine. As long as the efficiency of the latter was measured only by Carnot's Law, it appeared to be appallingly low, but when Rankine made the necessary correction for the conditions which obtain in a practicably operatable steam engine, engineers found reason for greater satisfaction. In the same way when the air standard is employed as a basis for the estimation of the efficiency of internal combustion engines, it is seen that instead of being very wasteful, they, in fact, are approaching the limits attainable under the conditions in which they operate. It is undesirable to press this comparison far; the point is that some unprofitable expenditure of energy is inevitable in all conversion processes, and that it is not quite fair to call it "waste" without differentiating between what could be avoided and what cannot. When, therefore, Mr. Engelbach speaks of the "appalling waste that occurs in the materials we use in the production of a car," he may give a wrong impression, unless it is clearly understood that "waste" is the difference between the actual expenditure of energy or materials and the least expenditure attainable under practical conditions and needs. For example, a great deal of the "waste" which occurs from the machining of castings is avoided in agricultural machinery by leaving them rough. But rightly regarded, it would not be waste if the purchaser preferred machined parts. Again, the form of body desired by the car purchaser involves the use of profiled sheets and the waste that results is considerable. It is, of course, possible to conceive a body design in which plain rectangular sheets alone were used and the "waste" reduced to very small proportions. But it would not be acceptable to the user. In other words, the user, in such cases, is more responsible than the engineer for the waste that occurs.

Whilst we advance these arguments to show that waste may not be as appalling as it seems when baldly presented, we are not attempting to undermine Mr. Engelbach's contention that a great deal of it is avoidable. Indeed, we might invite him to add to his study an examination of the waste involved in modern systems of office management, which in many cases cost too much for the efficiency they attain. It is the engineer's constant endeavour to reduce waste, and we have little doubt that Mr. Engelbach's address will have fruitful results. But, before we leave the subject, let us at least recall that if waste is one man's poison, it is another man's meat. By just so much as the motor car industry gains through the reduction of waste, the industries which supply the wasted material must lose. It takes 22 lb. of paint materials to apply 2 lb. of paint to the body of a car. If the waste is reduced by half, the paintmakers will suffer a reduction of output of 50 per cent. Hence, examined from the national point of view, it would appear that the reduction of waste in many—not all—cases can only be justified if it increases the demand for the products on which the saving is effected. That is an interesting economic reflection which we may leave to our readers. A few years ago it would not have called for much reflection; but nowadays, when it appears to be commonly held that the chief "industry" of every factory is the giving of employment, it wears a different aspect.

Co-operation in Science.

By S. C. BRADFORD, D.Sc.

THE early stages of specialisation of which Pope wrote, "One science only will one genius fit," have given place long since to concentration of individual genius within the narrowest subdivisions of special sciences. And now, with deeper knowledge, has come the realisation of the essential unity of all science. The barriers between the old departments of science are broken down and progress in one field may be felt in any other.

Thus the need for co-operation between the workers in all domains is recognised. Means of co-operation are being suggested, of which the bibliographical is the most fundamental. For before recorded information can be explained, or utilised, it must be located.

Few of those engaged upon the production of new scientific and technical data realise the enormous waste of energy in this process which is taking place. Two-thirds of the facts discovered are published, only to be buried in those cemeteries of books termed libraries. Some three-quarters of a million scientific and technical papers are issued every year. The same number of abstracts, or index references, are made in three hundred abstracting or indexing journals throughout the world. Yet only about one-quarter of a million papers are indexed or abstracted in published bibliographies, although it is evident that, without additional expenditure of energy, a complete index to scientific and technical literature could be realised forthwith.

The accomplishment of such an index requires the unification of existing bibliographies by the adoption of a standard system, whereby each fact is indexed, not in regard to a special science, but from the point of view of all science.

Before proceeding to the discussion of such a scheme some new data, which are essential to the proper understanding of the problem, must be recorded. Statistical analysis shows that the literature of a special subject is not confined to a comparatively small range of periodicals purporting to cater for that subject, or for the larger subject of which it forms a part. Such journals contain only a quarter or, at most, a third of the information in question. Papers on a given subject are distributed in such a way that the same number of papers will be found in three or more groups of periodicals, the numbers of journals in which are related as $1 : n : n^2$. Thus, in the subject of lubrication about a hundred papers a year are contained in a nucleus of some twenty periodicals. Another hundred papers occur in a larger group of about one hundred and twenty periodicals, in which each journal includes, on an average, about one paper on lubrication in a year. Outside this group there is a still larger group of about seven hundred periodicals, which contain another hundred papers on this subject at the rate of about one in ten years. Beyond this there are certainly other papers, which appear at rare intervals in a mass of periodicals.

The reason for the present failure of abstracting services now appears. To index the complete literature of a particular subject as it appears would need the weekly or monthly scrutiny of some thousands of periodicals, in the bulk of which relevant articles occur at the rate of from one a year to one in ten years or less. As this is not feasible, only the nucleus of those periodicals specially related to a subject is surveyed, with perhaps a selection of the more important journals in the next group. Thus a third, at most, of the literature of the subject is covered. And this is the extent of the finest bibliographies, as has been amply proved. It is evident that instead of abstracting by subject, periodical literature should be reviewed according to source. That is to say, every important article of each publication should be catalogued irrespective of its subject. If a standard system of classification were employed, as in the case of the International Catalogue of Scientific Literature, the notices, from whatever source, could be amalgamated into one index, or into a series of indexes by subject, where the references would be automatically sorted by the classification, all the entries relating to a particular topic falling together into one place.

It seems that a radical change in present methods of bibliography is needed. The alphabetical system, so much in vogue, is calculated to ensure the maximum of inefficiency and to prevent the possibility of co-operation. The fashion was surely invented by an office boy, who was instructed to index the subjects of his employer's correspondence. As the arrangement is found to scatter information on the same and related subjects throughout the alphabetical jumble, the index is loaded with time-wasting, and necessarily incomplete, series of cross-references, both from synonyms and related topics. Thus the alphabetical index is forced to attempt the reconciliation of the incompatible ideas of classification and alphabetical arrangement.

Those who need to use such compilations for serious work are fully aware of their inconvenience. There are usually half-a-dozen to a score of bibliographies relating to a particular field. At each inquiry each part of each volume of each bibliography must be worked through, piece by piece, every labyrinth of cross-references being followed to its farthest recess. The time expended amounts to hours or even days. And, in the end, there is the uneasy feeling that the indexers have successfully hidden much of the material. Some information officers take the trouble to cut up all the bibliographies they use, mount them on cards, re-head them, and bring them all together into one series, thus anticipating the general solution.

The most serious objection to the alphabetical method is that it necessarily perpetuates the present bibliographical chaos by rendering co-operation impossible. Not only must bibliographies relating to the same subject be kept separate, incomplete as they are, but the references to information on borderline subjects, which would be useful to workers in other fields of science, are hidden from their view. Thus data are indexed by the physicist that would be useful to the physiologist, by the botanist that should be utilised by the agricultural expert, and by the chemist that may be needed by the engineer. These facts remain hidden in their respective bibliographies by the uneconomic system. Yet, as has been seen, the information so hidden may represent the larger part of that upon a particular topic.

The way out of this confusion is obvious. "Let's go hand in hand and not one before another." General agreement to utilise a standard system would yield the desired index forthwith. This idea took shape so long ago as the First International Conference of Bibliography held in Brussels in 1895. The Conference decided that the Dewey Decimal Classification was founded on principles that would enable it to be developed into a satisfactory international bibliographical classification. The International Institute of Bibliography was founded in Brussels by Royal Decree to continue the work of the Conference. From its earliest stages such eminent names as Wilhelm Ostwald and Samuel Scudder were closely associated with the movement. In this country the first publication to adopt the Decimal Classification was "Natural Science," which began in 1896 the addition of decimal numbers to its articles in order "to prepare the way for that bibliographic reform, which all admit to be an urgent need." On the Continent a series of extensive bibliographies was inaugurated. These included, among others, a series of biological bibliographies on cards, the "Bibliographia Physiologica," the "Bibliographia Zoologica," and the "Bibliographia Anatomica," published by the Concilium Bibliographicum at Zurich, with the collaboration of the American Association for the Advancement of Science. Although the "Bibliographia Physiologica" has recently been suspended, the zoological and anatomical portions continue to constitute one of the most valuable bibliographies of any subject ever issued. When the necessary development of the classification had been completed, an extensive engineering bibliography was commenced under the title "Revue de l'Ingénieur et Index Technique." In 1925 this became the "Mededeelingen of the Dutch Institute of Documentation," and, recently, the "Repertorium Technicum."

Bibliographies of various other sciences were commenced, such as the "Bibliographia Geologica" in 1898, and the "Bibliographia Medica Universalis" in 1900. Unfortunately, energy, which might have accrued to the organisation, was diverted into other channels by the creation of a rival system. The Royal Society had taken the lead in bibliographical questions since the publication of its "Catalogue of Scientific Papers" from 1867 onwards. This constituted a list of papers under authors' names. An *index rerum* being needed, another International Conference was held in 1896, which made the fatal mistake of considering the philosophical order of a classification to be more important than its structure. The Conference resolved to set up a new classification, "in which the division of the subject matter in the various branches of science and the nomenclature to be used should be determined by competent bodies." In the result the inflexibility of its nomenclature rendered the classification unsuitable for indexing scientific literature on an international scale. Thus was missed a golden opportunity of establishing an international organisation, which must, almost inevitably, have provided a permanent solution to the bibliographical problem.

In the light of experience it is now easy to perceive another error in the decision of the 1896 Conference.

The error of too great centralisation. The organisation created resembled that corresponding to the higher branches of the animal kingdom in comprising a number of members activated from a single centre. When the central stimuli were inhibited by the World War the whole organism disintegrated. It is necessary to realise that the only control that is needed for the compilation of a World Index is that obtained by the use of a standard classification. The organisation of independent journals using a common classification, originated by the First International Conference of Bibliography, resembled a biological colony whose life is independent of those of its individual units.

In the result, the superiority of the classification and the methods of the International Institute of Bibliography have been demonstrated by its survival and increasing development. Despite the setback experienced in 1896, and the continual lack of even those few funds, which are needed for the proper administration of an international classification, the number, scope, and extent of bibliographies classified by the Decimal Classification have increased.

The Optical Society was the first scientific institution in Great Britain to adopt the Decimal Classification, which it did in 1926. Perhaps the greatest impetus was given to the movement by the foundation of the British Society for International Bibliography in 1927, whose honorary secretary is Mr. E. Lancaster Jones, at the Science Museum. Subsequently the classification was adopted by the Royal Society for the B Section of its "Proceedings," by the Royal Photographic Society, the Physical Society, the Physiological Society, the Imperial Agricultural Bureaux, and many other societies, research associations, and Government institutions, both at home and abroad, until the number of references classified has reached a hundred and fifty thousand annually, or 50 per cent. more than were contained in the International Catalogue of Scientific Literature.

As has been pointed out, the advantage of the system lies in the unification of the work of those adopting it, who thereby contribute towards the formation of a comprehensive index to recorded information. Specialists are enabled to select references to their particular subject from all published bibliographies using the standard system, and incorporate them in a special index to that subject; while large libraries can establish repertories, in which the entries from every source so classified fall together in a single series.

In such an index references to a given topic are brought together by the classification from every group of periodicals containing information on that subject; and references to border-line subjects are classified in such a way as to be available from whatsoever point of view they may be desired. Thus information recorded in a botanical journal is no longer hidden from the agriculturist to whom it may be useful. And all the instruments designed by physicists are labelled so that any one may be found by the physiologist at need. Thus the time of search is reduced from hours to moments at each consultation, while the range of the investigation becomes complete.

Such a repertory has been organised in the Science Library at South Kensington. The index now comprises two million cards covering all branches of science and technology. It is supplemented by an exceptionally extensive collection of miscellaneous bibliographies, which are estimated to contain in all some forty million references. The information service is administered by a scientific staff, who supply lists of papers on special topics on request. Periodicals, from a collection comprising more than ten thousand different sets, are also available for loan to scientific workers through the medium of approved institutions or industrial undertakings with which they are connected.

Partly owing to the success of the Decimal Classification, no doubt, interest in bibliographical problems is again reviving. An extensive review of bibliographical undertakings has been undertaken by an influential body. There are suggestions of more international conferences and for the creation of new classifications, proposals which are calculated to hinder the progress of bibliography and to repeat the expensive failure of the International Catalogue on yet a larger scale. We must consider whether any useful purpose is likely to be served by the international discussion of a problem already solved, and of which the solution has been demonstrated in practice on the largest scale. We have to realise that the whole art of bibliography is not to be comprehended in a day. There is a techique of bibliography, which is to be acquired only by training and experience. While we are seeking for savants to expound developments in their own domain, for the benefit of their colleagues working in other fields, let us be willing to accept the powerful instrument which bibliography places at our disposal, and thus achieve at last true co-operation in science, the need for which has for long been recognised.

Motor Car Developments.

The general and technical character of the Salon de l'Automobile, which opened in Paris last week, has changed with the altered conditions of the motor car industry. French makers have no longer the large and increasing foreign trade that enabled them formerly to extend their manufacturing facilities, and while they have made up some of the lost ground with a growing demand for commercial vehicles, the production of pleasure cars has been steadily declining. Several foreign markets have placed restrictions on the importation of cars. It is estimated that during 1932 the total production of cars in France, both private and commercial, was 171,222, while in 1931 the number was 196,079. This decline in business has had the usual result of stimulating makers to further research in the way of improvements, which are in most cases developments of ideas that have been put tentatively into practice for some years past. So long as rationalisation was the order of the day in the motor car industry, and makers sought to produce cheaply and sell at competitive prices, there was little prospect of any drastic change in car design, but following upon the trade depression, which compelled makers to strive after improvements that would encourage buying, the present Show differs from its predecessors in the presentation of many notable departures from former practice. These ideas are not new, for many of them have been imported from abroad. Their interest lies in the methods of applying them. The pre-selection of gears for synchronising the speeds of pinions before engaging them is worked out in different ways, though it may be remarked that some of the devices are demonstrated on chassis and are not standard fittings on cars offered for sale. Nevertheless, they are all presented by leading makers who would not introduce anything which they did not intend to identify with their cars. In one case, the rotation speeds are controlled by brakes to enable dog clutches to slip into the pinions easily. On the Panhard stand there is an arrangement worked by engine suction for automatically declutching and speed changing. Until recently, automaticity in car driving was deprecated by makers, who declared that the mechanical complication of devices to obtain it was undesirable, while it was argued that extreme facility in handling cars was really not necessary. The way was prepared for this easy car driving by the introduction of the four-speed gear-box, with two pairs of helicoidal pinions in mesh for silent changing, and now that almost complete automaticity has been obtained with a lever on the steering pillar, it is difficult to suppose that it will not become a feature in car design. This innovation lies to the credit of British car makers.

The suppression of direct connections between road wheel axles and the car frame marks another stage towards the provision of complete comfort to car users. Shock absorbers and other more or less ingenious suspensions have helped to attenuate the inconveniences of shocks and jolting on roads, and it is now sought to suppress them altogether by floating the frame on the road wheels. The problem is not easy of solution, since too much flexibility may cause more trouble than the road shocks themselves, and the devices employed must therefore not affect the lateral stability of the car. The most familiar method is the carrying of wheels on parallel transversal springs with hinged tension rods between the hubs and the frame; the Delahaye device is a modification of this arrangement with one transversal spring; the Panhard front axle is pivoted centrally on the frame; a German car has spiral springs between the axle and the frame with connections thereto by hinged yokes; Mathis relies upon a combination of shaft torsion and oil dashpot; and there are, in fact, many different ways of suppressing direct spring connections between the axles and the frame. For many years past cars have been built in France with floating bodies, but they have all disappeared, whether because the public was not prepared for them or because they revealed defects it is difficult to say. The problem is one that needs careful investigation, and as it implies the application of patented arrangements the practice of fitting cars with "independent" wheels will presumably extend gradually. The floating engine is evolved from the same desire to insulate the car body from vibration. A complete suspension of the engine is a delicate matter that has been accomplished in various ways with more or less success, and as progress in this direction is checked by the necessity of adapting a suitable suspension to particular engines the alternative of the three-point suspension with damper arrangements continues to find favour amongst some makers. The practically vibrationless character of some engines produced nowadays tends to lessen the importance of a flexible suspension. The growing practice amongst French makers to shorten engine stroke and run with higher compressions at greater speeds, coupled with facilities for control and gear changing, is in favour of the four-cylinder engine, which is less overshadowed by the six, eight, and twelve cylinder designs. A significant departure has been made by a leading French constructor of small cars who has gone over to the front wheel drive, and has arranged to build such cars under a German licence. The front wheel drive has never been anything more than an experiment, and all efforts to make it popular have failed, so that this mass production of a new type of car is an indication of the belief entertained by some French makers that a drastic change is necessary in order to shake the automobile trade out of its comparative lethargy. As presented, the new front wheel driven car offers distinct advantages in the way of providing ample room for a low frame and spacious body. It is of the floating type, with the rear wheels carried on brackets extending from the ends of longitudinal leaf springs and connected with the frame by hinged rods. This enterprise will show whether the front wheel drive can become a popular success.

Some compensation for the contraction of business in touring cars is provided by the activity of the commercial vehicle section, which is represented for the first time with the pleasure cars instead of lorries and vans, having, as formerly, a separate show of their own. The extraordinary development of road transport in France has been accompanied by progress in lorry design that is observable more particularly in the increasing use of the compression ignition engine and in the building of lorries to carry loads, in one case, up to 17 tons. Judging from complaints it would appear that some French lorry builders have exceeded the weights and dimensions of vehicles that should be permissible on the road. The driving control of such vehicles has necessarily received special attention from makers, and the big lorries are equipped with compressed air cylinders kept charged by an air compressor for actuating the brakes, and on the Renault lorry there is a compressed air servo-control of the steering gear, consisting of a double-acting piston which can be operated from the steering wheel for turning at sharp angles. The commercial vehicle has advanced as rapidly in essential practical details of design as the touring car has improved in refinement, and this progress is distinctly encouraging for an industry which has made great efforts during the year to prepare for a renewal of activity. It may, nevertheless, be supposed that competition will become increasingly keen for business.

Contrary to the experience of last year, there is a big foreign participation in the Show. Several German firms exhibit together under conditions suggesting that they form one commercial group. Some others have separate stands, notably M.A.N., with engines and a big lorry. The British industry is also well represented. The Show, on the whole, appears to indicate a turning point in motor car construction in the way of developing ideas that may have a permanent influence on the general design of motor vehicles in the future.

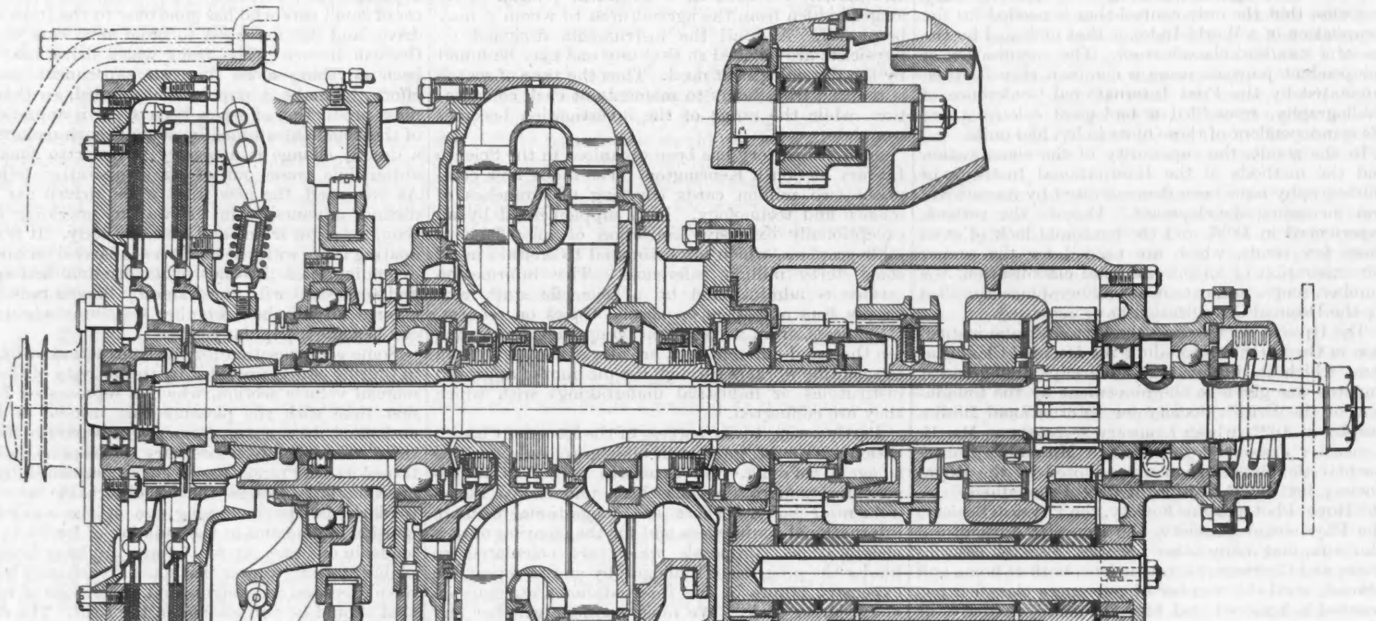
RAILWAYS IN THE PEAK DISTRICT.

The Wirksworth branch of the former Midland Railway has been somewhat in evidence of late because of the demolition of the occupation overbridge mentioned in our Seven-day Journal of September 29th. This short line of 8½ miles, opened on October 1st, 1867, is of historical interest in view of the part it was intended to play in the Midland Railway reaching Manchester. In the middle 'forties there was no railway communication in the Peak of Derbyshire between Ambergate on the Derby and Leeds of the Midland, and Stockport on the Manchester and Crewe Railway. There was, however, the High Peak Railway, opened in 1825, which joined the Cromford Canal with the Peak Forest Canal by a tramroad, but its gradients made it altogether unsuitable for a main line. The two companies named decided to build jointly a line from Ambergate to Stockport and the latter acquired the High Peak Railway. The scheme did not meet with the support of the London and North-Western when the Manchester and Crewe became part of that system in 1846, and it ended in a line being built from Ambergate to Rowsley, which, with the Cromford Canal, was leased to the L. and N.W. and Midland jointly. Because of that joint ownership with its great rival, the Midland determined upon an independent route from Derby through Wirksworth to Rowsley, and the Wirksworth branch, which leaves the Midland main line at Duffield, was the result. But it did not go farther. The L. and N.W. lease was to expire in 1871 and it was not therefore to that company's interests to fight, and the Midland first got a line from Rowsley to Buxton—sanctioned in 1860 and opened to Hassop on August 1st, 1862, and completed on June 1st, 1863—and from Millers Dale to the Manchester, Sheffield and Lincolnshire at New Mills—sanctioned in 1862 and opened on January 24th, 1867. The bridge on the Wirksworth branch, just destroyed, was an occupation overbridge to connect two portions of property that tbe new railway divided. Its construction is indicative of what railway companies paid in those days for compensation to landowners.

As an extraordinary example of welding of inflammable materials, satisfactory welds have, says Mr. A. Stephenson, in the *Journal* of the Royal Society of Arts, been made of celluloid with the acetylene-air flame, but not with the oxy-acetylene.

HYDRAULIC TORQUE CONVERTER, CLUTCH SYSTEM, AND REVERSE GEARBOX

LEYLAND MOTORS LTD., LEYLAND, LANCASHIRE, ENGINEERS



An Hydraulic Torque Converter.

SINCE the early days of motoring "crash" gears have been in use in the transmission systems of petrol-driven road vehicles. It is only within the last few years that devices that may mitigate the difficulties of gear changing or do away altogether with the gear-box have been developed. In any case, whatever device is fashioned to take the place of the conventional gear-box, it must have the characteristic of coupling the engine to the road wheels flexibly; that is, the engine must be able to run at a high speed while the road wheels are rotating slowly and the torque developed by the engine must be multiplied in the final drive shaft. Several types of hydraulic transmissions have been developed for road vehicles since the war, but except for the fluid fly-wheel, of which the characteristics still demand that a gear-box shall be included in the transmission system if the best results are to be obtained, no such device has come into general use.

On a recent visit to Leyland Motors, Ltd., of Leyland, Lancashire, we were privileged to inspect a hydraulic torque converter on the Lysholm-Smith system, which the firm is now putting into production. At the Commercial Motor Transport Exhibition, which opens at Olympia, London, on November 2nd, this converter will be shown as an alternative transmission system to the conventional clutch and gear-box in motor coaches and omnibuses. Several engravings accompanying this article illustrate the construction of this device, the most useful of which for reference purposes is the sectional drawing reproduced above. A glance at that drawing is enough to show that more is indicated there than merely the torque converter itself. On the engine side there is a system of clutches and on the other a reverse gear-box.

Since the characteristics of the torque converter itself influence the design of the other parts shown in the drawing it will perhaps be best to begin our description with that mechanism. It is, as might be inferred from the drawing, of the hydraulic type. One of the tone engravings—Fig. 1—shows the various parts of the device separated. Driven by the engine, there is a rotor in form much like the impeller of a centrifugal pump. Partly surrounding the "impeller" is the "rotor," which is connected to the road wheels and upon which are mounted three rows of blades not unlike those of a steam turbine. The casing into which these two parts fit carries two rows of fixed blades, which guide the hydraulic fluid on to the blades of the "rotor." The relative positions of the fixed and moving blades when the converter is assembled may easily be followed from the drawing. The hydraulic fluid follows, of course, a closed path, being driven outwards by the "impeller" and travelling inwards through the blades of the rotor. Its pressure varies from about 25 lb. per square inch at the centre to about 50 lb. per square inch at the outside.

Although this converter is a form of hydraulic coupling, its design is distinctively different from that of a fluid fly-wheel and its characteristics, as might be expected, are also different. Whereas a fluid fly-wheel is constantly in use, it does not take the place of a gear-box, while this torque converter, which takes the place of a gear-box, is not constantly in action; it is, in fact, at its best at low vehicle speeds and, when a certain optimum speed is reached, it is "cut out" of action and a change over is made to direct drive. What that optimum speed may be depends on the design of the converter and the arrangement of the blading. Since a continuous high rate of acceleration, uninterrupted by the necessity to change gear, is obtainable when the device is in use, this torque converter is likely to make a place for itself in the transmission systems of omnibuses designed for service in urban areas. The constant starting and stopping in such service will give scope for the converter to develop its accelerative possibilities while relieving the driver of the labour of continual gear changing. In Fig. 3 there is reproduced a graph supplied to us by the makers showing the acceleration obtainable with an ordinary gear-box and with the torque converter. Both curves refer to the "Titan" type of omnibus. For the reasons given above a speed of about 20 miles per hour has been adopted as the optimum for the converter drive, and for greater speeds a clutch mechanism is provided, by the use of which a direct drive may be obtained.

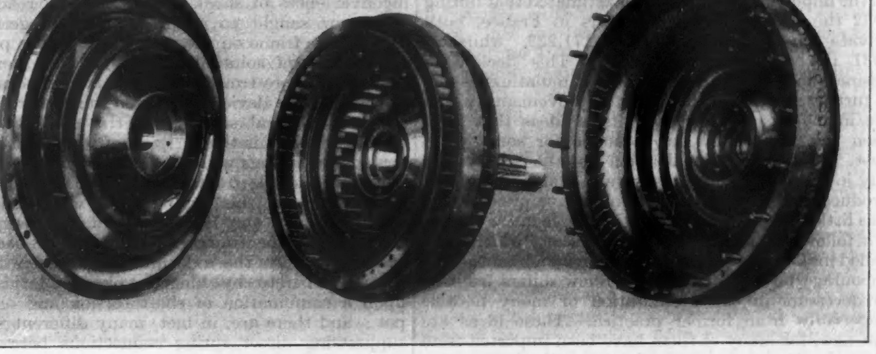


FIG. 1—PARTS OF HYDRAULIC TORQUE CONVERTER

On the end of the engine crank shaft there is mounted a dished fly-wheel encasing the clutch plates. There are two sets of plates, either of which may be brought into action by a mechanism that is so clearly indicated in the drawing and the tone engraving, Fig. 2, that there is no need further to refer to it. A "neutral" position when neither clutch is engaged is also available. By bringing the left hand set of plates into action a drive is obtained directly from the engine to a solid central shaft passing right through the arrangement of mechanisms under discussion and connected at its further end to the road wheels in a perfectly straightforward, normal manner. Thus direct drive is obtained. Throwing over the clutch-actuating mechanism to its alternative position connects the engine to a sleeve surrounding the central shaft and forming part of the "impeller" of the torque converter. The details as to how the central shaft and the sleeve are carried on ball and roller bearings clear of one another may be followed from the drawing. Following up the drive through the torque converter, it will be seen that a sleeve enclosing the central shaft also forms part of the "rotor" and projects into the reverse gear-box. About midway along the length of the gear-box it is externally splined to carry the moving portion of a dog clutch. Slid to the right—see the drawing above—this clutch engages with the inner member of a free-wheel mechanism, the outer member of which is mounted on the central shaft. The drive is thus transmitted from the "rotor" of the converter through the free-wheel to the central shaft and thence to the road wheels. This position is that normally occupied by the dog clutch, and the reason for the insertion of the free-wheel, even if it were not a desirable feature in other respects, will be realised after a moment's consideration. For when direct drive is engaged the "rotor" of the converter would be turning at the same rate as the central shaft and churning the oil with a consequent loss of power if it were not for the presence of the free-wheel mechanism. As the free-wheel is present the two rotary parts of the converter are both left free to rotate or remain stationary according to the effect of any small frictional forces that may act upon them. To obtain reverse the dog clutch is disengaged from the central member of the free-wheel and slid towards the left. Since the engine is running, as soon as this clutch is disengaged the "rotor" of the converter will begin to turn, carrying with it the sliding member of the clutch. At the same time the pinion of the reverse gear train with which the dog clutch is to engage is held stationary by its connection with the road wheels through the idler gear, lay shaft, and central shaft. To bring the "rotor" to rest the mechanism is so arranged that a simple cone clutch first makes engagement; subsequently, when rotation has been prevented, the outer ring of the dog clutch sliding member engages with suitable teeth cut on the side of the "reverse" pinion. The illustration Fig. 4 shows the central shaft and the various parts that are situated in the gear-box.

The general arrangement of the complete mechanism having now been described, it remains to refer shortly to several details. Firstly, those wise in the design of centrifugal pumps will see that by allowing the oil from the central portion of the converter to have access to the outer sides of the "impeller" and "rotor" over part of the area hydraulic balance is at least partially obtained, so that any residual thrust is easily taken by the large ball bearings on which the rotors are mounted. The most serious possibility inherent in the design is that leakage of fluid from within the converter may take place. Since the pressure of the oil within the converter may rise in the central space to 25 lb. per square inch, special precautions are necessary. To prevent the oil leaking out through the clearance between the "impeller" and "rotor" to the space around the central shaft and thence escaping longitudinally along that shaft, a copper bellows gland is fitted between the two rotating parts. Similar copper bellows glands prevent the oil escaping from the spaces behind the rotors along the outer surfaces of the sleeves. It is impossible, however, to prohibit leakage altogether, nor in the interests of lubrication would it be desirable to do so, and special passages are provided in the casing to collect any oil that does escape. These passages are easily traced on the drawing. A reserve oil tank is mounted on the dashboard of the chassis, and the leakage oil is conveyed to this tank by an injector, the high-pressure oil for which is obtained from the "pressure" side of the converter. A similar injector forces the oil from the reserve tank back into the spaces behind the "rotors" of the converter.

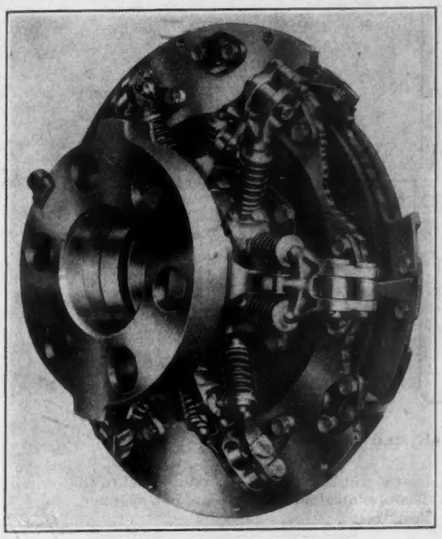


FIG. 2—CLUTCH OPERATING MECHANISM

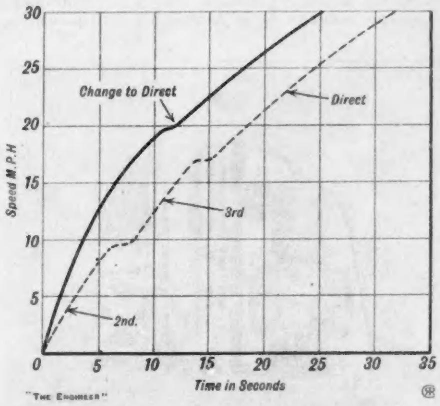


FIG. 3—"ACCELERATION" CURVES

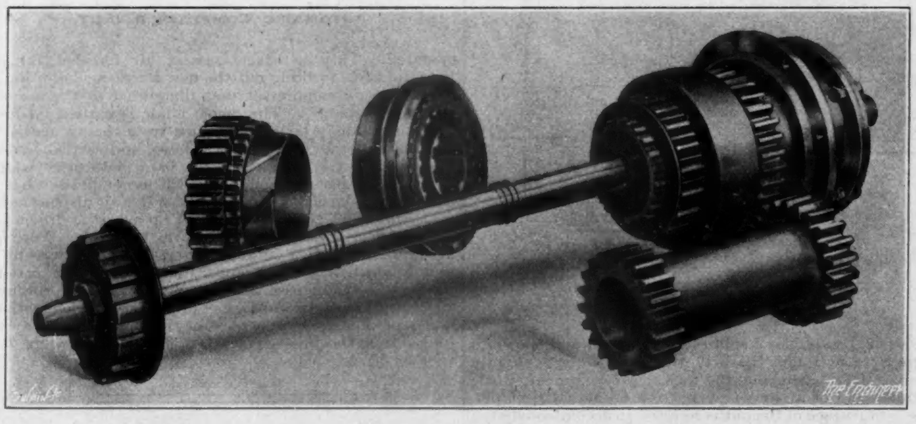


FIG. 4—CENTRAL SHAFT AND PARTS SITUATED IN GEARBOX

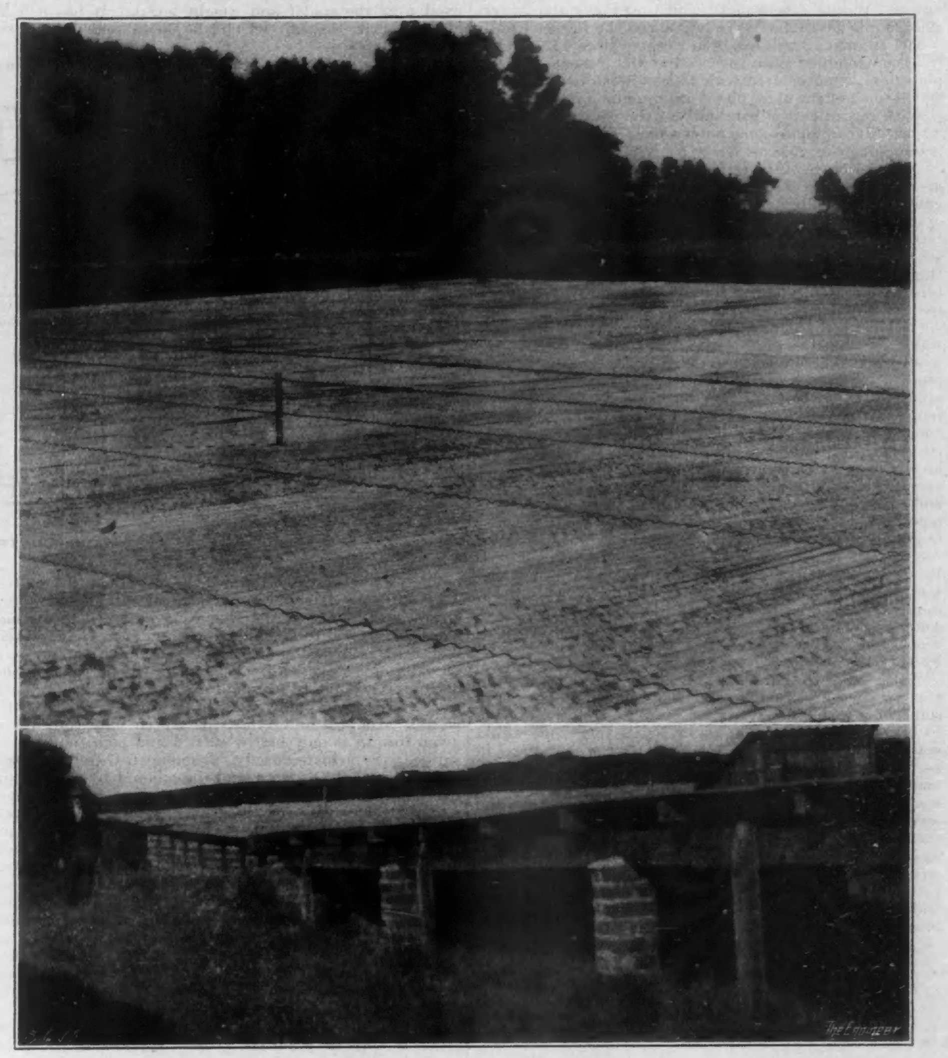
Under certain conditions new fluid, when introduced into the converter, may gasify to a slight degree. To avoid the possibility that trouble might arise from this cause a permanent "leak-off" pipe is provided at the top of the casing, through which the fluid flows to the reserve tank already mentioned. A small air-cooled radiator is included in order that prolonged use of the converter under extreme conditions—on a long steep gradient, for instance—shall not cause an undue temperature rise of the fluid. Usually a mixture of paraffin and lubricating oil or ordinary fuel oil, as used for compression-ignition engines, is used in the converter.

While we were at the works we were given the opportunity of testing a TD-3 "Titan" chassis, fitted with one of these converters on the road. The controls under the charge of the driver comprise an accelerator, brake pedal, and a lever controlling the clutches for "direct" or "converter" drive. There is, of course, no gear changing in the ordinary meaning of the term. The chassis was fitted with a petrol engine developing a maximum output of 110 brake horse-power. At speeds below 20 miles an hour with the converter in operation a great degree of flexibility is obtained. For instance, the vehicle, while climbing a hill, was required to turn to the right into a main road. It was baulked by the arrival of another car coming along the main road. In an ordinary omnibus or lorry the circumstances would have called for a rapid gear change at a time when the driver was occupied in avoiding the other vehicle. With the converter in operation, however, it meant no more than releasing the accelerator pedal for the few seconds necessary to allow the other vehicle to pass and subsequently depressing it again to accelerate smoothly across the road. The impossibility of stalling the engine was demonstrated on a steep hill, when the vehicle was allowed to come to rest and even to run backwards with the engine running. The smoothness with which the drive was taken up when the accelerator was again depressed was also noticeable. Having found a straight piece of road, which, unfortunately, was not absolutely level, we, personally, obtained the following acceleration figures by the use of a stop watch and the speedometer fitted to the vehicle :—

Speed.	Up. Seconds.	Down. Seconds.	Average. Seconds.
10 m.p.h.	4	3	3·5
15 ,,	6	5·25	5·62
20 ,,	12	10·5	11·25

The chassis with its load weighed 9 tons 17 cwt. and carried five passengers when these readings were taken, and, except for the torque converter, was standard in every respect. Owing to its smoothness the rate of acceleration was very deceptive to the passengers, seeming very much less than it really was. At 20 m.p.h. the change was made to direct drive. These tests fully justified the opinion of the manufacturers that the "torque converter" vehicle might appeal to omnibus service operators.

RAIN WATER CATCHMENT FOR A COUNTRY HOUSE



The Water Supply of a Country House.

THROUGH the courtesy of Mr. C. J. P. Cave, of Petersfield, we are able to give some technical particulars of a rain-water catchment he has erected in his grounds for the water supply of his house. Whilst the normal rainfall in the Petersfield district is on the high side—40in. p.a.—and thus favours the method he has adopted, yet the arrangement is so simple that other landowners who are forced to depend upon rain will be glad to have the following notes about the construction and operation.

Broadly, the catchment consists of an area of corrugated iron sheets laid upon wooden supports carried on short brick piers, as shown in the accompanying illustration. The sheets are laid with a slight fall towards a central gutter which runs transversely across the catchment. The sheets are raised about 4ft. above the ground at the outer ends and 3ft. at the centre, and the total effective area is 7670 square feet. The catchment is roughly square, measuring about 90ft. each way, with, however, a piece cut out to allow access to the valves which control the outlets of the tanks. Below the catchment there are brick tanks lined with cement, but the rain water passes through a gravel filter before entering these tanks. About 3000 gallons of water are secured for a rainfall of 1in.

In consequence of the small slope of the sheets—about 1 : 50—Mr. Cave found that there was a tendency for the water to run back under the edge owing to capillary attraction and thus fall outside the cross gutter. The loss that occurred in this way was considerable—between

30 and 40 per cent.—but rather than go to the trouble and expense of moving all the plates further forward over the gutter Mr. Cave adopted the following ingenious plan. He drilled holes in the valleys near the lower edge and dropped through them nails, which overhang the gutter. This simple device has entirely stopped the former loss.

The original system has been working since 1921, but it has been enlarged since then and at the present time the plates are being painted with cement wash to check rust which some of the older plates are beginning to show.

With regard to the potability of the water, we cannot do better than quote some notes which Mr. Cave has been good enough to give us.

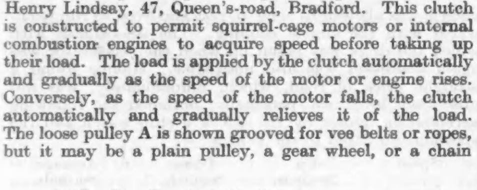
"As to storage of the water, I have always found that it keeps perfectly in the underground tanks. At one time we gave an extra filtering to the drinking water, but, in my opinion, this was quite unnecessary, and as a matter of fact we are not using the extra filter now. I cannot understand the prejudice against rain water stored in tanks. I think it must arise from people letting rain water run into tanks without filtering it through gravel. Our water is quite palatable and quite tasteless.

"I have had trouble with pipes owing to the very soft water. I understand that rain water takes up CO_2 very readily and that this makes it slightly acid. Anyhow, the pipes of the hot water supply (not the central heating apparatus) gave trouble. The hot water used to run very red, and after a time pipes began to leak, and others got choked up, and I had to renew a number. I am told that the pipes that were most affected were what, I believe, are known as red steam pipes, and I do not know how these came to be used. This house was originally a farmhouse and has been added to more than once. Anyhow, the new pipes are galvanised iron pipes. But to guard against anything of the sort happening again I installed a water 'softening' apparatus of Messrs. Boby and Co., of 62, Brook-street, which has the effect of neutralising the acidity of the water. This seems to have made a great improvement; the hot water no longer runs red. The water is still quite soft, but it is not as excessively soft as it was before. All the water that is pumped into the roof by the electric pump passes through the apparatus.

"This house stands 750ft. above the sea, and parts of this parish of Froxfield are over 800ft. above the sea. The soil is clay with flints overlying chalk. A well would have to be very deep to obtain water, and I fancy one would not know till one had sunk it how ample the supply would be. Almost all the parish depends on rain water, but many of the farms have a very inadequate supply. I consider that my catchment has been a great success, and several times in recent years I should have had to shut up the house and go away if I had depended only on the water from the roof. This year we have had an ample supply, and I have enough water to carry me on till January without any further rain, allowing 400 gallons a day; and we have not had to economise in water at all or even to ask people to be careful about bath water."

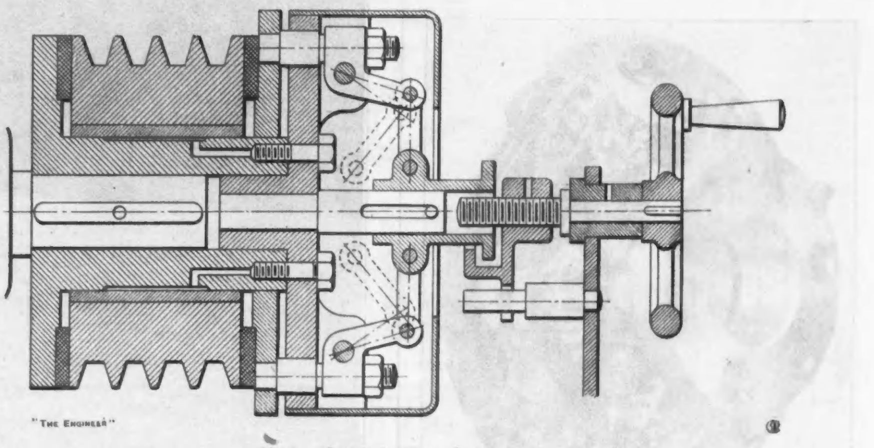
Automatic Centrifugal Clutch.

We illustrate herewith a design of automatic centrifugal clutch of the plate type developed and produced by Mr. Henry Lindsay, 47, Queen's-road, Bradford. This clutch is constructed to permit squirrel-cage motors or internal combustion engines to acquire speed before taking up their load. The load is applied by the clutch automatically and gradually as the speed of the motor or engine rises. Conversely, as the speed of the motor falls, the clutch automatically and gradually relieves it of the load. The loose pulley A is shown grooved for vee belts or ropes, but it may be a plain pulley, a gear wheel, or a chain sprocket wheel. It is mounted between a boss plate M keyed to the driving shaft and a pressure plate N sliding on the boss of the plate M. Friction surfaces composed normally of compressed cork are attached to these two plates to establish contact between them and the edges of the loose pulley. Attached to the end of the boss of the plate M and revolving with it is a spider to which two or more bell-crank levers W are hinged. These levers are of about 3 to 1 ratio, and are constructed in the form of weights. Each contains an adjusting screw, the point of which bears against the pressure plate N. As the motor gathers speed centrifugal force causes the weight levers to exert an increasing thrust on the pressure plate. Slipping occurs at first at the friction surfaces, but as the speed rises still farther the thrust exerted by the weight levers gradually becomes sufficient to cause the loose pulley to pick up the speed of the driven shaft. The adjusting screws provide a means of taking up wear of the friction surfaces. The compressed cork employed for these surfaces is stated to be very resistant to wear, and to possess the valuable characteristic of not losing any material portion of its driving capacity when it becomes greasy. A light aluminium cover is fixed over the spider and weight levers. It has a hole at its centre through which the loose pulley may be lubricated.



AUTOMATIC CENTRIFUGAL CLUTCH

For use in conjunction with single or two-phase motors having a low starting torque, the action of the clutch may be delayed by means of control springs extending between the ends of the weight levers. These springs can be subjected to fine adjustment and can be employed if desired as a means of causing the clutch to slip at a predetermined overload. It is pointed out that as the drive is transmitted through friction surfaces on both sides of the loose pulley, the thrust to be exerted by the weight levers, in order that the clutch may transmit a given torque, is only half what it would be if the friction surface were on one side only. Economy is thereby effected in the size of the weights, and the amount by which they overhang the shaft is reduced. There is no actual clearance between the driving and the driven parts, and, as a consequence, the clutch operates without backlash or vibration.

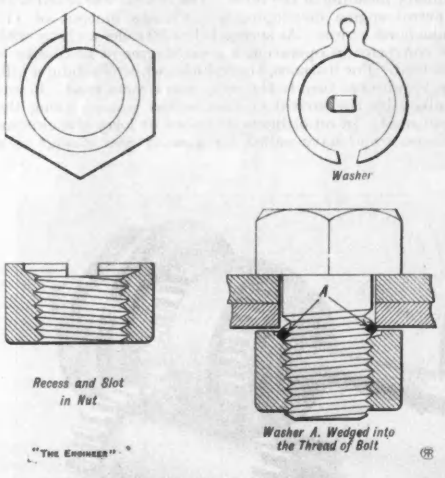


HAND-CONTROLLED CLUTCH

In our second engraving we illustrate a modification of the design in which the automatic action of the clutch is replaced by a hand control. In this case the thrust on the pressure plate is exerted by bell-crank levers linked to a sliding collar controlled by a hand wheel and screw. If the position of the motor is adjustable on slide rails two flat bars are inserted between the feet of the motor and the rails, and the motor fixing bolts passed through them. These bars are extended and at their end carry the bracket in which the control screw of the clutch is supported. By this means the position of the motor on its rails may be adjusted without dislocating the hand control gear.

A New Lock Nut.

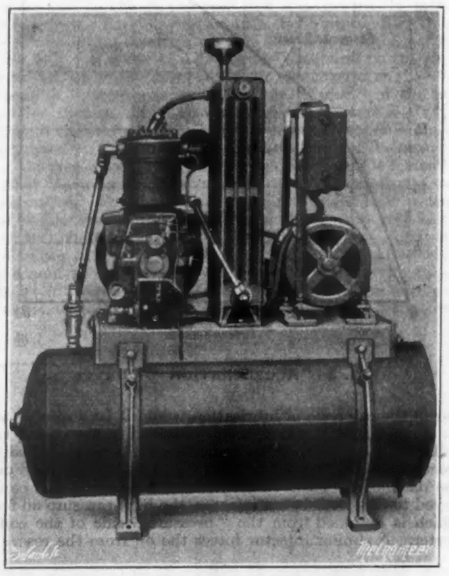
The "Dean" locknut illustrated herewith is made by the Aerogen Company, Ltd., Chalk Farm-road, London, N.W.1. It is claimed to be a simple and effective combination of a nut and a washer that will hold tight on a bolt against violent and long-continued vibration and to be capable of being removed easily and repeatedly without doing damage to either the nut itself or the bolt. The "washer" resembles a split pin opened out and bent into a circle to fit round the bolt with the two ends slightly apart. In an emergency the washer can be quickly made with the aid of a pair of pliers from an actual split pin. The contact face of the nut is recessed to accommodate the washer, a slot being cut from the recess to one of the nut corners to take the folded head portion. The bottom of the recess is coned. When the nut is screwed down against a metal surface the washer, by virtue of its half-round shape and the conical bottom of the recess, becomes slightly twisted and is kneaded into the thread all round the bolt and also into the turn of the thread extending below the plate surface. The tongue of the washer held by the slot locks the nut against loosening under vibration. An additional locking action is produced by the head of the washer lying in the slot. When the nut is nearly home this head makes contact with the metal surface and, lying as it does at a considerable leverage, produces an imperceptible tilting which has the effect of slightly "bastardising" the thread. The washer is made of soft iron and is claimed to cause no damage to the thread. The same nut can be used repeatedly on the same bolt with a new washer at each application. The effort required to loosen the nut is stated to be about equal to that required to shear a pinned nut with the aid of a spanner.



THE "DEAN" LOCKNUT

An Automatic Compressor Unit.

More and more is the modern garage becoming mechanised. It is only a surprisingly short while ago that all greasing was performed with the hand-operated grease gun, and the setting of tire pressures was achieved with a foot pump. A back-aching crawl was necessary if some adjustment had to be carried out beneath the car. The coming of the automatic compressor set has altered all that. Nowadays, greasing and tire-pumping are performed by the help of air pressure; air-operated tools are used in the repair department, and few "up-to-date" garages can afford to be without a hoist, frequently air operated. This increasing use of air has led B.E.N. Patents, Ltd., to bring out the new larger model of automatic electric compressor unit illustrated in the accompanying engraving. The whole affair is carried on four legs within the "bows" of which rests the air receiver, 20in. diameter by 60in. long. Above, and carried by the legs and not the receiver, is the base plate upon which the working parts are mounted. The compressor has a bore and stroke of 4in. by 4in., with a free air displacement of 20 cubic feet per minute at 695 r.p.m. It is driven by a 5 H.P. electric motor through a twin "V" belt. Working in conjunction with a suitable starter, there is a "pressure" switch which makes the apparatus automatic in action. Between the compressor and the motor a radiator, through which the cooling water flows by thermo-syphonic action, is mounted. The compactness of the whole affair may be judged from the dimensions. It is 5ft. 6in. long by 2ft. 7in. wide by 5ft. 3in. high.

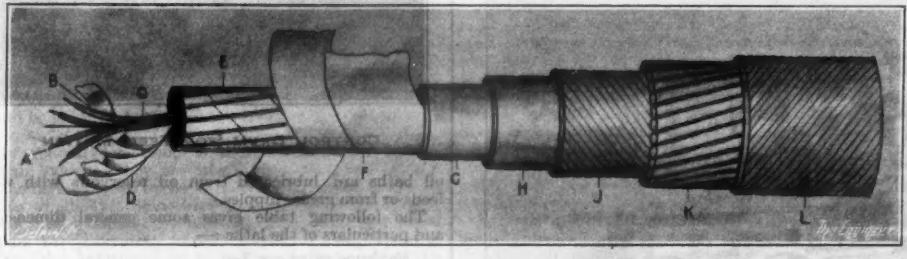


AUTOMATIC COMPRESSOR UNIT

The Anglo-French Telephone Cable.

Details are now available of the Anglo-French submarine telephone cable, which was laid on September 18th from St. Margaret's Bay, near Dover, to the Bassin des Chasses, near Calais, for use in connection with the proposed "on demand" trunk service to the Continent. From the English shore the cable is extended by an unarmoured lead-covered length of similar cable core drawn into a conduit and running to a repeater station on the cliff above the landing point. At the French end it is connected to a tape-armoured cable about 1½ miles long, terminating at a repeater station on the outskirts of Calais. As the distance between repeater stations is such as to ensure satisfactory transmission, the cable is not loaded. A land cable connected to the submarine cable at St. Margaret's Bay extends to London and is provided with suitable repeater stations, whilst on the French side a new cable has been laid to connect the Calais repeater station with Paris. The cable is designed for four-wire working. Speech from London will reach Paris by way of one pair of wires in the quad, while the return speech will be transmitted over the other pair in the same quad. In addition to the circuit at audio frequency provided by each quad there will be another circuit operated at a carrier frequency.

Some of the circuits in the new cable will terminate at Paris, while others will be extended to Geneva, Rome, Madrid, Marseilles, and other large Continental cities. The telephone facilities will not only be increased, but a higher grade of speech will also be obtained. The accompanying illustration shows the construction of the cable.

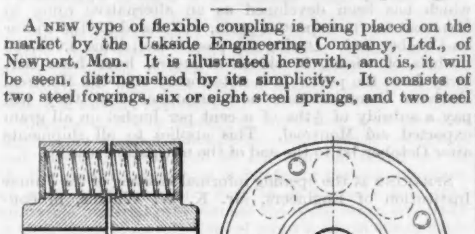


DETAILS OF THE ANGLO-FRENCH TELEPHONE CABLE

A is solid annealed copper wire weighing 66 lb. per statute mile and with a diameter of 0·064in. B is insulation composed of helical lappings of undyed insulating paper, C four conductors insulated in this way and stranded on a paper centre to form a compact quad. Insulated conductors at the ends of each diagonal of the quad form a telephone pair, which may be used separately or as a part of a four-wire circuit. Each quad, lapped with paper D, is marked for identification and is electrostatically screened by means of a helical lapping of metal foil, nineteen quads E being stranded into a compact cable. The stranded cable is covered with a lapping F of stout cut cotton tape and insulating paper and is sheathed, as indicated at G, with an alloy containing about 99 per cent. Imperial lead, the diameter being 1·58in. A waterproofing covering of rubber treated with rubber tapes is shown at H, a covering of compounded and tarred jute yarn to form a bed for the armouring at J, an armouring of twenty-five specially compounded No. 2 gauge galvanised iron wires at K, and a covering of special waterproof compounds and tarred jute yarn at L. The finished diameter of the cable is 2·95in. The main contractors were the Telegraph Construction and Maintenance Company, Ltd., and Standard Telephones and Cables Ltd. acted as sub-contractors.

The Uskside Flexible Coupling.

A NEW type of flexible coupling is being placed on the market by the Uskside Engineering Company, Ltd., of Newport, Mon. It is illustrated herewith, and is, it will be seen, distinguished by its simplicity. It consists of two steel forgings, six or eight steel springs, and two steel cover plates. The makers claim that it is extremely flexible, and inform us that they propose to manufacture it in all sizes from 5 to 1000 H.P. or more. They are at present producing one to transmit 200 to 300 H.P. for use in conjunction with heavy-duty mine haulage gear. The new design takes the place of flexible couplings employing rubber blocks or rubber sleeves previously made by the company.



USKSIDE FLEXIBLE COUPLING

Public Works, Roads and Transport Congress and Exhibition (1933).

THE Congress Organising Committee of the Public Works, Roads and Transport Congress and Exhibition, which is to be held at the Royal Agricultural Hall between November 13th and 18th, has issued the following preliminary programme :—

MONDAY, NOVEMBER 13TH.

At 3 p.m., conference under the auspices of the Institution of Sanitary Engineers on "The Re-sewerage of Guildford," by Mr. J. W. Hipwood, M. Inst. C.E., M. Inst. M. and Cy. E., M.R. San. I., Borough Surveyor of Guildford; Chairman, Mr. H. C. Adams, M. Inst. C.E., M.I. Mech. E., F.R. San. I., President of the Institution.

At 3 p.m., conference on "Town Building L.C.C. Cottage Estates (Post-war)," by Mr. H. Berridge, C.I.E., O.B.E., M. Inst. C.E., M. Inst. Mech. E., late Assistant to Administrator, L.C.C. Housing Development Schemes; Chairman, Sir Arthur B. Lowry, C.B., Deputy Secretary, Ministry of Health.

TUESDAY, NOVEMBER 14TH.

At 11 a.m., conferences under the auspices of the Society of Chemical Industry on (*a*) "Laboratory Tests and their Correlation with Full-scale Road Experiments," by Mr. R. G. C. Batson, M. Inst. C.E., M.I. Mech. E.; (*b*) "Some Factors Involved in the Mechanical Testing of Bituminous Mixtures," by Mr. W. G. Adam, B.A., M.I. Chem. E., F.I.C., and Mr. D. G. Murdoch, B.Sc., A.I.C., A.M.I. Chem. E.; (*c*) "The Mechanical Testing of Bituminous Road Mixtures," by Mr. Prevost Hubbard, Chemical Engineer, The Asphalte Institute, New York; Chairman, Major F. C. Cook, D.S.O., M.C., M. Inst. C.E., Deputy Chief Engineer, Ministry of Transport.

At 11 a.m., conferences under the auspices of the Institution of Gas Engineers on (*a*) "Dry Purification: Some New Methods for its Control," by Mr. W. A. Currie, jun., A.M. Inst. Gas E., Technical Assistant, Glasgow Corporation Gas Department; (*b*) "Qualities of Tars for Use on Roads," by Mr. W. E. Cone, Technical Adviser, British Road Tar Association; Chairman, Mr. F. P. Tarratt, M. Inst. C.E., M. Inst. Gas E., President of the Institution.

At 3 p.m., conferences under the auspices of the Society of Chemical Industry on (*a*) "The Mechanical Testing of Asphalt," by Mr. D. M. Wilson, B.Sc., A.I.C.; (*b*) "Mechanical Tests and the Modern Highway," by Mr. D. C. Broome, M.I.P.T., and Mr. A. R. Thomas, M.I.P.T.; (*c*) "Mechanical Testing of Bituminous Road Materials," by Professor Dr.-Ing. E. Neumann, Stuttgart, Germany; (*d*) "Mechanical Testing of Road Materials—Italian Practice," by Signor Vandone, Italian Roads Laboratory, Milan; Chairman, Professor G. T. Morgan, O.B.E., D.Sc., F.R.S., Past-Vice-President of the Society.

At 3 p.m., conference under the joint auspices of the Association of Public Lighting Engineers and the Institution of Gas Engineers on "The Lighting of Arterial Roads by Gas," by Mr. A. M. Bell, A.M. Inst. Gas E., Public Lighting Superintendent, Tottenham and District Gas Company; Chairman, Mr. E. M. Severn, President of the Association of Public Lighting Engineers.

WEDNESDAY, NOVEMBER 15TH.

At 11 a.m., conference under the auspices of the Institution of Municipal and County Engineers on "Specifications in the Light of Tradition, Experience and Research," by Mr. B. Price Davis, F.S.I., M. Inst. M. and Cy. E., M.R. San. I., L.R.I.B.A., City Engineer, Bangor; Chairman, Major L. Roseveare, O.B.E., M. Inst. C.E., Borough Engineer, Eastbourne, President of the Institution.

At 11 a.m., conferences under the auspices of the County Land Agents' Association on (*a*) "Allotments and Small Holdings," by the late Mr. F. H. Osmond-Smith, F.S.I., formerly County Land Agent for Glamorgan; (*b*) "Rats and Musk Rats," by Mr. M. A. C. Hinton, Deputy Keeper of Zoology, Natural History Museum; Chairman, Sir Charles J. Howell Thomas, K.C.B., C.M.G., Permanent Secretary, Ministry of Agriculture and Fisheries.

At 2 p.m., distribution of prizes by the Right Hon. Sir Hilton Young, Minister of Health.

At 3 p.m., conferences under the auspices of the Institution of Municipal and County Engineers on (*a*) "The Development of Road Bridges in Great Britain," by Mr. C. H. Bressey, C.B., C.B.E., F.S.I., Chief Engineer, Roads Department, Ministry of Transport; (*b*) "The Design of Superstructures for Small Bridges," by Mr. H. C. Adams, M.A., Assoc. M. Inst. C.E., Assistant Engineer, Roads Department (Bridge Section), Ministry of Transport; Chairman, Sir Henry P. Maybury, G.B.E., K.C.M.G., C.B., President of the Institution of Civil Engineers and Chairman of the Congress Organising Committee.

THURSDAY, NOVEMBER 16TH.

At 11 a.m., conferences under the auspices of the British Waterworks Association on (*a*) "Pooling of Supplies by Interconnection of Water Undertakings and their Trunk Mains through Rural Areas," by Mr. Alan E. L. Chorlton, C.B.E., M.P., M. Inst. C.E., M.I. Mech. E.; (*b*) "Water Pollution Research," by Dr. A. Parker, D.Sc., M.I. Chem. E., F.I.C., Secretary and Assistant Director of Research, Water Pollution Research Board, Department of Scientific and Industrial Research; Chairman, Mr. G. M. Robertson, J.P., Chairman of the Fylde Water Board, President of the Association.

At 11 a.m., conferences under the auspices of the Institution of Municipal and County Engineers on (*a*) "Office Efficiency in a Highways Department," by Mr. E. Tasker, Chief Engineering Assistant, Gloucestershire County Council; (*b*) "Control over Highway Expenditure," by Mr. P. Tait, Finance and Statistics Department, Ministry of Transport; Chairman, Mr. C. H. Bressey, C.B., C.B.E., F.S.I., Chief Engineer, Roads Department, Ministry of Transport.

At 2.45 p.m., conferences under the auspices of the British Waterworks Association on (*a*) "The Financial Management of Municipal Trading Departments," by Mr. Sydney Larkin, F.S.A.A., F.I.M.T.A., City Treasurer, Coventry; (*b*) "Water Supply and Fire Protection," by Mr. John Smith, Chief of the Belfast Fire Brigade; Chairman, Mr. G. M. Robertson, J.P., President of the Association.

At 3 p.m., conference under the auspices of the Institution of Municipal and County Engineers on "Some Considerations Affecting the Economical Reconstruction of Rural Roads," by Mr. D. G. R. Tiddy, F.S.I., M. Inst. M. and Cy. E., District Highway Surveyor, Somerset County Council; Chairman, Major L. Roseveare, O.B.E., M. Inst. C.E., Borough Engineer, Eastbourne, President of the Institution.

FRIDAY, NOVEMBER 17TH.

At 11 a.m., conferences under the auspices of the Institute of Sewage Purification on (*a*) "Recent Developments in Methods of Sewage Works Analysis," by Mr. J. T. Thompson, M.Sc., F.I.C., Chemist and Works Manager, Knostrop Sewage Works, Leeds; (*b*) "The Disposal of Surplus Activated Sludge," by Mr. H. D. Bell, F.I.C., F.C.S., Manager and Chemist, Barnsley Sewage Disposal Works; Chairman, Mr. J. Haworth, M.B.E., F.I.C., Sewage Disposal Works Manager and Chemist, Sheffield, President of the Institute.

At 11 a.m., conference under the auspices of the Institution of Municipal and County Engineers on "The Design and Construction of Municipal Aerodromes," by Mr. T. L. Roberts, Assistant Engineer, Anglesey County Council; Chairman, Mr. E. A. Sandford Fawcett, C.B., M. Inst. C.E., late Chief Engineering Inspector, Ministry of Health, and Vice-Chairman of the Congress Committee.

At 3 p.m., conferences under the auspices of the Institute of Sewage Purification on (*a*) "Present-day Conceptions of Sewerage and Sewage Treatment," by Mr. Granville Berry, Engineering Assistant, Nelson; (*b*) "The Logical Design of Separate Sludge Digestion Plant and its Effect upon other Phases of Sewage Treatment," by Mr. A. S. Lowe, B.Sc., A.M. Inst. C.E., A.M.I. Mech. E.; Chairman, Dr. H. T. Calvert, M.B.E., D.Sc., Ph.D., F.I.C., Chemical Inspector, Ministry of Health.

At 3 p.m., conferences under the auspices of the Institution of Municipal and County Engineers on (*a*) "Private Street Works," by Mr. A. O. Mitchell, Private Street Works Assistant, West Sussex County Council; (*b*) "Vibration in Roads and Buildings," by Mr. C. H. Bradbury, A.M. Inst. C.E.; Chairman, Major L. Roseveare, O.B.E., M. Inst. C.E., President of the Institution.

SATURDAY, NOVEMBER 18TH.

At 11 a.m., conference under the auspices of the Institution of Municipal and County Engineers on "Vehicle Design in Relation to Public Cleansing," by Mr. J. E. Swindlehurst, M.A., A.M. Inst. C.E., Borough Engineer, Hampstead; Chairman, Major L. Roseveare, O.B.E., M. Inst. C.E., President of the Institution.

Letters to the Editor.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

TRADE WITH SCANDINAVIA.

SIR,—May I suggest to British manufacturers who are looking for markets abroad that they are likely to be well repaid by giving especial attention just now to the requirements of the Scandinavian and Baltic countries? The first condition of trade is the goodwill of buyers. Having just concluded an extensive business tour around that part of Europe, I am able to say that this condition, applied to British products, is everywhere in evidence to a conspicuous degree throughout the Scandinavian and Baltic countries at the present time.

Testimony to it in Finland has been given by the very remarkable demonstrations in connection with the "British Week" there. Esthonia testifies to it by buying, for the first time in its history, more goods from Great Britain than from any other country, including Germany, which for years has held first place among all countries supplying Esthonia's imports. In Norway, Denmark and Sweden I saw repeated evidence of a desire to buy British goods in preference to other imports, wherever British goods could compete upon equal terms.

One sign of the friendly disposition towards this country is the very great interest which is being taken in the Scandinavian and Baltic countries in the study of English. The records of my own organisation provide something of a barometer in this respect. At one time courses in German and French were far in excess of English courses in the Baltic and Scandinavian countries; now English easily predominates, with French second and German third. In all the Scandinavian countries I found that the study of English is being pursued intensively for both commercial and cultural purposes. In Esthonia and Latvia, instruction in English has been made part of the general curriculum in secondary schools.

These are straws which show the way the wind is blowing. I am convinced that it may easily prove a favourable trade wind for British manufacturers if they will go a little out of their way to take full advantage of it.

J. ROSTON,
Principal, Linguaphone Institute.

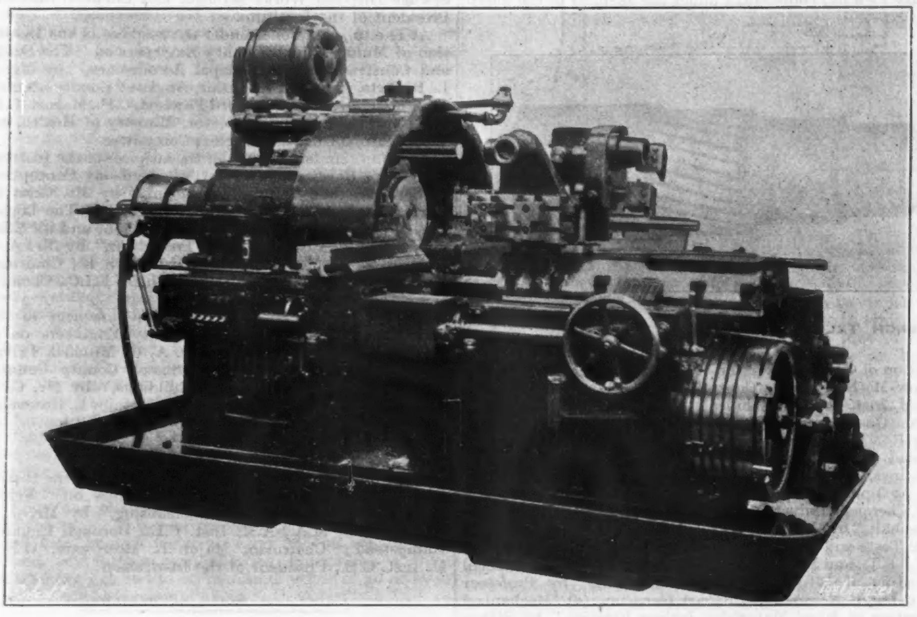
London, W.C.1, October 6th.

IT is announced that Lord Moyne, whose yacht "Roussalka," lost off the Irish coast towards the end of August, was formerly the Southern Railway Company's steamer "Brighton," has purchased the same company's steamer "Dieppe" for conversion into a yacht. The "Dieppe," which was built in 1905 by the Fairfield Shipbuilding Company, Ltd., is propelled by triple-screw steam turbines. Her measurement is 1426 tons gross, with a length of 273·5ft. and a beam of 34·8ft.

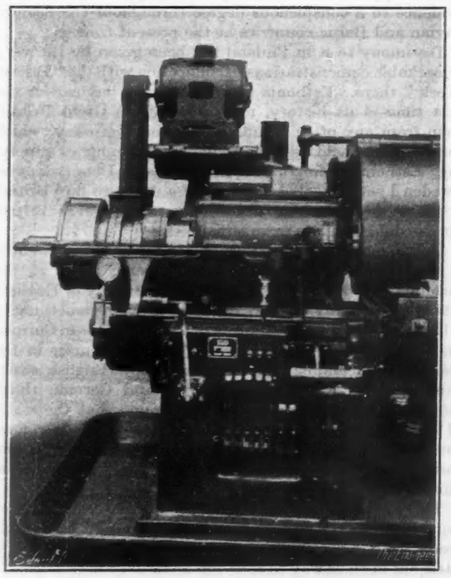
New Heavy Duty Auto-Lathe.

◆

A MACHINE designed expressly to take advantage of modern high-speed cutting alloys, with a speed range wide enough to enable all materials to be machined at the highest practicable speeds, strongly constructed to withstand the stresses arising from heavy cuts, and a new production from the works of Alfred Herbert, Ltd., of Coventry, is illustrated by the engraving below. From this engraving and the other photographs reproduced, the general design of the machine will be made clear, and we need only refer to some special details. The driving box is bolted to the back of the bed behind the headstock, and its weight is supported by an extension of the bed. As shown in the engraving, the drive is taken by multiple V belts from an electric motor mounted above on a hinged base plate carried by the driving box, but a drive from a line shaft can as easily be arranged. In all, twenty-eight spindle speeds are available, in seven ranges of four speeds each. By this means any of the seven ranges of four may be chosen as suitable for the work in hand, and automatic changing of the speeds within that range is then available. If required the changes can be made when the tools are actually cutting. The seven ranges are obtained by means of five sets of pick-off gears that connect two of the shafts in the driving box, and the four speeds in each range are obtained from two multiple-disc friction clutches.



New Heavy Duty Auto-Lathe



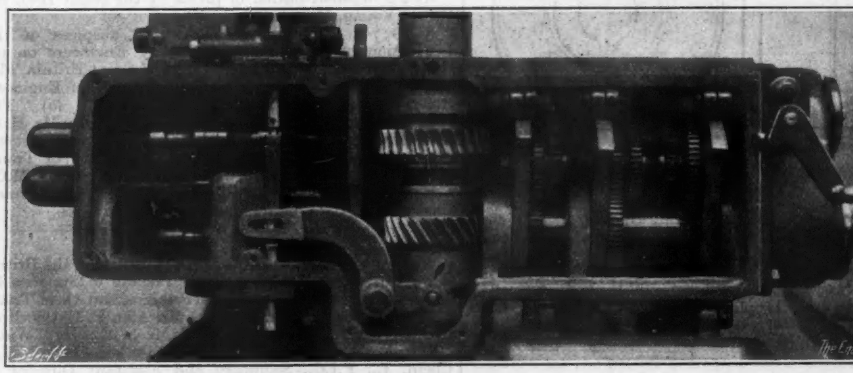
Headstock End and Speed Change Box

In addition to the automatic speed changes, it is also possible to stop the spindle automatically and re-start it. Power-driven cams in the driving box bring about the speed changes. Five bell-crank levers, each of which has a detent that retains a long plunger, are arranged in a speed change box below the headstock. Each plunger passes through the bed to the driving box, and in the normal position is just clear of one of the speed change cams. Adjustable dogs may be clamped in grooves in a drum beneath the headstock and, tripping the bell-crank levers, enable them to release the plungers which, being forced into engagement with the cams by springs, make the changes of spindle speed. The bell-crank levers have arms projecting towards the front so arranged that they may be lifted by the fingers for changing speed when setting up. It will be noticed that although only four spindle speeds are available, there are five sets of bell-crank levers. One is for starting and stopping the spindle. The lever to be seen next the bell-crank lever arms also controls the starting and stopping of the spindle.

The turret has four faces and is indexed rapidly by a Geneva motion in the slide actuated by worm gearing. After indexing it is automatically clamped firmly to its seat. Its slide is actuated by a cam drum that makes two rotations for each forward and return stroke. As the slot in the cam drum is cut like a screw which returns upon itself, the slide is moved back and forth very smoothly and steadily, even when taking heavy cuts.

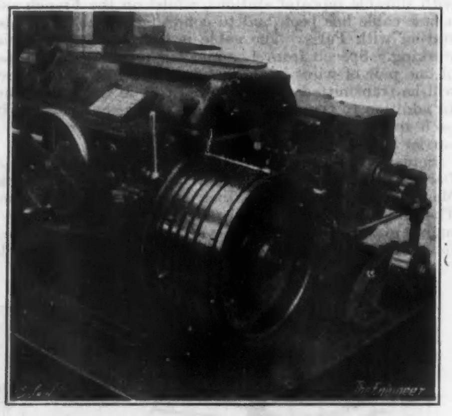
The two cross slides are quite independent. Each lower slide is a box-shaped structure, which supports the upper slide and contains the operating mechanism. The bed covers attached to the turret slide to protect the ways of the bed pass through openings in the lower cross slides. Cam drums actuate the upper cross slides, making one turn to feed them in and another to withdraw them. The length of stroke is adjustable. This automatic motion of the slides is derived from the control drum beneath the headstock. Adjustable dogs are carried in the grooves on the right-hand end of this drum. They actuate levers which, by a suitable arrangement of connecting-rods and shafts, engage clutches through which the cross slide cams are driven. At the end of the stroke the mechanism is automatically disengaged and the slide remains stationary until another dog on the control drum actuates the lever, when the slide will be withdrawn.

The feed motion is controlled by means of a continuously rotating cam in the feed box and a mechanism similar to that used for making the spindle speed changes. There are eight ranges of three feeds, each giving twenty-four feeds in all. Like the spindle speed changes automatic alterations of the range of three feeds may be made while the tools are cutting. The control drum is mounted at the end of the bed, and may be seen in one of the engravings reproduced.



Feed Box with Cover Removed

Like many other machines constructed by the same firm, considerable use has been made of anti-friction bearings in the auxiliary mechanisms of this lathe, as well as in the main components. Nearly all the high-speed shafts are carried in such bearings, and the spindle is mounted on large roller bearings specially made for the purpose. Two opposed double-purpose ball bearings take the thrusts and also part of the journal load. The question of the lubrication of all these bearings has been carefully studied, and according to the makers the arrangements are such that hand oiling with the oil can is practically eliminated. The main units, such as the driving box, headstock, and feed box, are lubricated by oil baths and pumps, while the slides and such bearings as are not in oil baths are lubricated from oil reservoirs with wick feeds or from grease nipples.



Control Drum for Feed Motion

The following table gives some general dimensions and particulars of the lathe :—

Maximum swing over bed	16½in.
Maximum swing over cross slides, using full stroke	9in.
Adjustment to headstock along bed	6in.
Adjustment of cross slides along bed	6½in.
Maximum stroke of cross slides ..	4½in.
Minimum stroke of cross slides ..	1in.
Working stroke of turret slide	10in.
Maximum distance from flange of spindle to face of turret..	27in.
Minimum distance from flange of spindle to face of turret..	11in.
Diameter of hole in spindle	3in.
Size of each face of turret	7¾in. × 5in
Diameter of base of turret	12¾in.
Diameter of tool holes	2½in.
Height of centre of tool holes above slide	$3\frac{13}{16}$in.
Diameter of single pulley	9in.
Width of belt	4in.
Speed of pulley, r.p.m.	700
Number of spindle speeds	28
Total speed range, r.p.m.	24 to 490
Number of speeds obtained by automatic changes	4
Number of feeds	24
Total feed range, cuts per inch.. ..	12 to 253
Number of feeds obtained by automatic changes	3
Horse-power	10
Speed of motor	1430
Floor space occupied	10ft. 3in. × 5ft. 6in.

The new port of Churchill, on Hudson Bay, Canada, which has been developed as an alternative route to Montreal for the export of grain, was closed for the winter on October 2nd. During the past season some 3,000,000 bushels of wheat, in eleven steamers, have been sent away from the port. It is noteworthy that the Montreal Harbour Commissioners now announce that they will pay a subsidy of $\frac{3}{16}$ths of a cent per bushel on all grain exported *viâ* Montreal. This applies to all shipments after October 1st to the end of the navigation season.

Speaking at the opening informal meeting of the Junior Institution of Engineers, Mr. K. W. Willans, in considering what effect the modern system of education had upon the widespread unemployment manifested in many directions and not least in engineering, suggested that it should be the aim of technical colleges to instil into the minds of the young the necessity of their getting to work with their hands and not thinking that their time had been wasted if they failed to get a " black-coated " job, and he questioned incidentally whether anything had had a greater effect on the production of labour troubles in this country than the black-coated ideal. He considered that the right time to go to college was between the ages of twenty and twenty-three, after a complete course of practical training.

Thirty-five Years on the Railway—and After*

By WILLIAM WHITELAW.

In these days of scientific research, to which the railway industry must always attach the utmost importance, I cannot help thinking that there is a danger of forgetting how rich an education there is to be found in the actual performance day by day of the duties of every grade in the railway service, whether in the office or out on the line.

In this connection, the question of the value of examinations as a means of finding the best candidates for certain vacancies in the railway service, and of discovering the best talent among existing employees, is worth consideration.

Personally, I have always disliked the examination system, and have rated examiners rather low in the scale of humanity, since the days when I came in contact with them, and I attach only a moderate value to its results. To begin with, there is no truth in the view that a man who, at any age up to twenty years, displays his superiority in an examination will ten years later still be the superior of someone who had scraped through or actually failed in the same examination. Constant observation has revealed to me that many of the most valuable men of thirty years of age in practical work have been drawn from those who, ten years previously, would be found to have been low down in the examination list.

My general conclusion is that examinations have a certain value, if they are wisely conducted, and are not of themselves held to be conclusive evidence either of genius or idiocy. Sometimes it would be a good thing to test the examiner by allowing those who had failed to pass an opportunity to set a paper for the purpose of ascertaining how much he himself really knew about the subject of the examination.

Railway managers engaged in the practical management of their companies would have an easier life if they were able at times to disregard the theories of the engineer, the kindly autocracy of the accountant, and the restrictions imposed by the legal adviser.

Among the questions which occur to one are such as the following—Have permanent way engineers made sufficient allowance in estimating the life of their roads for the greater weight of rails and chairs, better fastenings, more efficient creosoting of sleepers, more attention to good drainage, and the greatly extended use of stone ballast in place of gravel or ash? I can recall a short piece of line near Inverness lying very near the sea level, where drainage was difficult, which was a source of constant trouble and expense until by the adoption of stone ballast it was transformed beyond recognition. Have they made any allowance for the wonderful improvement in the balancing of locomotives, so that a locomotive weighing 120 tons or more may be much lighter on the road than one of older construction weighing much less?

Permanent way can now actually be tested from a running train and facts ascertained about matters which were formerly in the region of theory or guesswork, call it what you will!

Much of what I have said about the permanent way is also true of bridges. Only a few years ago engineers had to condemn girder bridges on mathematics, where to-day their strength can accurately be measured, and fact by displacing pure theory has added years of life to many a railway bridge.

I daringly suggest it is possible that, in the past, unnecessary expenditure has been incurred on renewal of the permanent way, because its life was estimated wholly upon theory, and that actual inspection and practical testing thereof to secure reliable facts as to its condition may well lead to definite savings in this branch of railway expenditure.

Another source of savings in connection with the civil engineering department will be found in the collection and careful inspection of all old material taken out of the line, and the separation of it into the various categories of good, indifferent, and bad, so as to make sure that no usable material ever reaches the scrap heap, especially in these days when to get rid of scrap is one of our difficult problems. I doubt if I shall ever again experience, as I once did, the sale of scrap rails at a higher price than had been paid for them when new.

A good instance of settling a problem by practical experience instead of by theory, was found in certain locomotive trials which were carried out in 1910 on the London and North-Western line between Carlisle and Preston. I was anxious to find out by actual experiment what were the respective values of a six-coupled and an "Atlantic" engine on the Waverley route of the North British Company, as I was wondering if the North British "Atlantic" was the best possible type for that route, and the intention was to run trials between the North British "Atlantic" and the London and North-Western six-coupled engine between Carlisle and Edinburgh. This intention had to be departed from as it was found that the dome of the London and North-Western engine was rather higher than was safe for running under one or two bridges on the Waverley route, and the change was accordingly made to the line between Carlisle and Preston. Each engine hauled the same train in both directions, the weight of the train being 284 tons. The L.N.W. engine was No. 1483, named "Redgauntlet," weighing about 103 tons with six-coupled wheels 6ft. 3in. in diameter, an axle weight of 18½ tons, and the boiler having a pressure of 185 lb. per square inch. The "Atlantic" engine was No. 881, named "Borderer," weighing nearly 120 tons with 4-4-2 arrangement of wheels, 6ft. 9in. in diameter, an axle weight of 19½ tons, and a boiler pressure of 190 lb. per square inch. Neither engine was fitted with a superheater. On the up journey, "Redgauntlet" took 110½ min. and "Borderer" 109¾ min. On the down run, "Redgauntlet" took 102½ min. and "Borderer" 102 min. These are the times given on the London and North-Western report on the trials, and show no difference as regards timekeeping. The most interesting point, however, in the test was that, contrary to what might have been expected, the six-coupled engine took 10 min. to climb the hill from Tebay to Shap Summit, while the "Atlantic" accomplished the climb in 9 min. This was wholly due to the "Atlantic" engine having been able to pass through Tebay at 62 m.p.h. against the speed of only 57 in the case of the six-coupled engine; as a matter of fact, the last half-mile threatened to see "Borderer" come to an ignominious stop, which was averted only by the frantic efforts of the fireman. These efforts were reflected when the coal consumption came to be reckoned up. The consumption of "Redgauntlet" was 58 lb. per mile, and that of "Borderer" 71 lb. The outcome of the trials was to indicate that each company had, apart from the coal consumption, the engine most suitable for its road, the 4-4-2 wheel arrangement being more suitable for the many more severe curves on the Waverley route than are to be found between Carlisle and Preston. The trial, of course, opened the North British eyes to the extravagance of the coal consumption of their engine, and that question was tackled with no small success by Mr. Reid, the locomotive superintendent of the company, though he could never reduce the consumption to anything like that of the L. and N.W. engine. Locomotive science has made such progress since these days and the greatly increased weight of trains has altered the problem which then had to be decided; to-day, the "Pacific" reigns supreme on the Waverley route.

Perhaps there is no more important work in the whole range of railway management than the compilation of the time-table. I attach more importance to the punctual working of both passenger and freight trains than to the running of a few trains at spectacular speeds, or for long distances without a stop, however successful these may be in securing headlines in the daily Press. Nothing gives passengers so much satisfaction or attracts them so much to a route as the regular punctual arrival of trains at their destination.

A frequent cause of bad train working really begins, curiously enough, with the appearance of a new and more powerful engine. All goes well for a few weeks when the engine is more than master of its load; then someone in the superintendent's department surreptitiously adds another vehicle or two to the train, and then it is found that the train is too long for some platforms with the result of introducing the greatest enemy of punctuality—a double pull-up. Nothing but a study of all the actual facts so as to make certain that the running staff are not being asked to do the impossible will permit of a high degree of punctuality being secured and maintained. What after all, is the control system? It is just applying judgment to the actual facts as they exist hour by hour in the daily running of trains; it is the highest form of practical train working, and is a most valuable daily source for the supply to the superintendent of the facts about his train running which he would otherwise never obtain in time to be of any great use.

Thus, while one starts the compilation of a time-table with the theory that a train of given weight can run a certain distance in a certain time, it is the actual daily practical experience on the footplate, in the guard's van, on the station platform, and in the shunting yard that renders possible the really punctual running of the whole service.

One might spend an hour or two speculating upon the theory of the Railways Act of 1921, and the practical results which have flowed from it. The main theory of the Act was that an economic basis for the amalgamated railways would be found by stating the remuneration to which owners of railway capital should be entitled, the appointment of one Tribunal to fix wages and conditions of labour and another to ascertain and fix the rates and fares which would, under efficient management, provide the cost of labour and the proper remuneration of capital.

The latter Tribunal has year by year given the companies its certificate of efficient and economical management, but has found its duty of fixing rates and fares for the proper remuneration of capital in the face of the cost of labour, as fixed by its sister Tribunal, to be impossible of discharge. The Act had assumed that there would always be traffic awaiting conveyance at the necessary rates and fares, and Parliament does not seem to have given any consideration to the situation which has actually arisen, in which the traders are clamouring for lower rates and greater rapidity in conveyance, while even at the existing rates the economic position aimed at has not nearly been reached. Here, certainly, is an instance of the breakdown of theory before the irrefutable facts which have dominated the railway situation for the last ten years. Another theory of the Act, which, I think, has proved to have been sound, was that only by a policy of amalgamation could the railway system over the whole country be maintained. I have little doubt that, but for the Act, some of the old railway companies would have ceased to function; probably one or two of them could not recently have earned their working expenses. Even amalgamation has not been able to save some branch lines from partial or total closing down, and I daresay we shall see further closing down yet.

During the last thirty years I have been doing what little I could to overthrow the era of frantic competition and to promote co-operation in the policy and management of the railways; as I look back on those years I realise how little was accomplished until recently.

Has the amalgamation policy of the Act of 1921 been a success? is a question often put to me. To find the answer one must, of course, make an estimate of what the position of the former companies would have been to-day, and I have already indicated that, in my opinion, disaster would have fallen upon some of them. There is a tendency to denounce the whole amalgamation policy merely because, after ten years, three of the four companies have failed to earn any dividend on their Ordinary Stocks; those who set up as critics of the policy must tell us what would probably have been the dividend position of the companies had they continued to occupy their respective independent positions as in 1913; until they do so, I think their criticisms require no answer.

I am by no means satisfied that the fullest possible co-operation has yet been established between the companies of to-day; there is room for wider and more complete systems of pooling than have yet been agreed to. Nevertheless, there is an amount of co-operation far beyond anything that could ever have been attained under the organisation of 1913, and I am hopeful that future years will see a constantly increasing growth of pooling policies and co-operative working.

The era of competition expired with the advent of the war. No single company, and, I am sure, no railway manager ever suggested that during the war, when the national interest stood paramount, the railways could be conducted except under a single command, and with a common purse out of which should be disbursed to each company a proportion of the whole receipts, in no way varying with the route of the traffic. Just as during the war the traffic was routed in accordance with the interest of the State, as the supreme trader, by the Executive Committee, so to-day there is only one sensible method of routing traffic, and that is by the cheapest and quickest route in the fewest possible number of vehicles, and with the least possible amount of shunting, thus serving the real interests of the trader, the traveller, and the railway system as a whole. Every hour that a traffic officer spends in devising how to divert a wagon from its natural route is an hour lost to economic transport.

Perhaps I shall find few supporters for the policy of complete abolition of competition between railway companies, but I am comforted by the fact that time is on my side, and the knowledge that the young railwaymen of to-day are not being educated in the school in which the older among us were brought up, and which taught that the highest efficiency in railway commercial policy was to be found in the unrelenting plan of playing the not very exalted game of Begger-my-neighbour.

The essential principle of conducting railway traffic ought to be the adoption of such a complete system of pooling as would put it out of the power of any railway company to earn profit by competition with another; plenty of work can be found for the die-hards of competition by concentrating their efforts on dealing with the new competition in the transport world of to-day.

One of the most vital points in the administration and management of very large railway companies is wide decentralisation. With such decentralisation I do not think the total disappearance of competition among railway companies need have any terrors either for traders or for the travelling public. On the contrary I believe that all interests affected by railway transport in this country have nothing but gain to expect from the extension of pooling systems and the further unification of railway administration.

I shall perhaps be told that I am advocating the establishment of a monopoly! Well, I do not deny it! But it would be a regulated monopoly under the provisions of the Railways Act of 1921, which are ample to prevent exploitation, there being effective control of rates and fares by an independent Tribunal, and a provision by which any profits secured beyond the standard laid down must, to a large extent, go to the reduction of charges.

When I became chairman of the North British Company I realised that the work was totally different to what it had been at Inverness, and that any very close attention to detail would render the discharge of the chairman's duty impossible. A further surrender of detail was obviously necessary when seven companies were amalgamated to form the London and North-Eastern Company, and thus my varied experience of the chairmanship of three companies, each of the latter two infinitely larger than its predecessor, taught me that as a company increases in size, more and more decentralisation of administration is essential. As in the administration so in the management; the spreading of the responsibility becomes more and more necessary as the task increases in volume and complexity, but with adequate decentralisation there seems to me to be hardly any limit to the size of a company which can be put under one control. It is all a mixture of personal control and wide diffusion of responsibility throughout the geographical area served by the company.

An apt illustration of what I mean is found in that delightful nonsense verse written, I think, by Sir Theodore Martin, whom all railway directors, managers, and solicitors of the last generation will remember, entitled, "The Massacre of Macpherson." It is in the Highland dialect;:

> Fhairshon had a son
> Who married Noah's daughter,
> And nearly spoil'd ta flood
> By trinking up ta water;
> Which he would have done,
> I at least pelieve it,
> Had ta mixture peen
> Only half Glenlivet.

I for one would have no fear of the unification of even all the railways provided that the concentration of the "Glenlivet" was suitably countered by the water of diffusion in the administration and management of the whole. Probably it will be said that that would be just the penultimate step to nationalisation.

The statesmen of the future will be well advised not to be frightened by a name, even though it does not "smell sweet." National management of the railways would prove, I do not doubt, ruinous to both passenger and industrial transport, but national ownership, with management completely divorced from political influence is not impossible, and cannot be dismissed from consideration for all time because of the prejudice attached to the name of nationalisation.

Following a meeting of local authorities in Liverpool, held some time ago with the object of forming an Advisory Regional Smoke Abatement Committee for Merseyside and South-West Lancashire, a similar conference has taken place in Newcastle-upon-Tyne. This conference, convened by the Newcastle Public Health Committee, has also been successful, and it has been agreed to form an Advisory Regional Committee for Northumberland and Durham.

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* Abstracted from the Presidential Address to the Institute of Transport, delivered in London on October 9th, 1933.

South African Engineering Notes.

(By our South African Correspondent.)

Electricity Schemes.

The Kroonstad Town Council has decided to proceed with a £60,000 electricity scheme which will involve the installation of an entirely new generating plant and the replacement of direct current by alternating current. The scheme was approved by the ratepayers two years ago, but the Council would not put it into commission, owing to the fact that money was too dear. Somerset West ratepayers have sanctioned the raising of a loan of £4000 for the purpose of extending the electric lighting installation of the town and providing two new sub-stations. The Fransch Hoek Municipal Council has completed negotiations with the Electricity Supply Commission for a supply of electricity. The work of erecting a transmission line and distribution mains is to be started immediately. The Lichtenburg Town Council is considering the installation of a new and up-to-date lighting scheme for the town; the proposals are for a new oil plant, developing alternating current, to cost about £12,000. The town of Gwelo is going into the question of additional plant, the present installation being barely able to cope with the increasing demands. An electric lighting scheme for the new capital of Northern Rhodesia, Lusaka, has been agreed upon, and instructions have been given to proceed with it as early as possible. The City of Cape Town invites tenders for the supply and delivery to Dock-road power station of an alternator set. East London contemplates spending £50,000 in extending its electrical installation. Bloemfontein City requires £20,000 for the installation of additional cables, transforming apparatus, meters, &c. An up-to-date all-electric station and control tower is to be built at the Rand airport at Germiston. Outshoorn town is asking for a loan of £31,000 to transform its existing power system to one of alternating current, also for new generating plant with the necessary boilers, &c.

Subsidising Italian Vessels.

Great astonishment was created in commercial and shipping circles by the agreement of the Union Government to subsidise two Italian shipping lines to the extent of £150,000 per annum to start a service between Genoa and Africa, in addition to two Italian lines at present running. For the subsidy the lines undertake to run four big liners of 20,000 to 24,000 tons at an average speed of 18 knots, and which will do the trip between Cape Town, Marseilles, and Genoa in 14 days 15 hours—the Union-Castle Mail steamers from London to Cape Town take over 16 days. The idea is that these Italian liners will carry cargo from Italy, France, Switzerland, and other countries, even Jugo-Slavia, Rumania, Austria, Poland, &c. The service will call at Ludentz, Walvis Bay, Lobito, Matadi, Lagos, Freetown, and Dakar. The Union Government further expects to extend trade with Kenya, Tanganyika, Aden, Egypt, Nigeria, and Belgian Congo, as the lines will run *viâ* the East and West African ports. It does not seem that the very small trade done by the Union with East and West Africa warrants any such subsidy, and the prospects of increasing the present trade seem small, as all the places named are already well served by British lines. The granting of the subsidy came as an entire surprise to commercial and shipping firms throughout the Union, and is regarded as a distinct blow to British shipping prestige. The whole matter will undoubtedly be thrashed out when Parliament meets. The only tangible claim made by the Minister of Commerce and Industry, who is responsible for the agreement (Mr. A. P. J. Fourie), is that the Italian companies will purchase S.A. coal and ships' stores in the Union to the amount of about £100,000 per annum. This is doubtful, in view of the extent to which oil is superseding coal for bunkering. It would appear that the Italian Government has striven hard to get this agreement accepted by the Union Government, and is subsidising these new lines—as far as running to S.A. is concerned—to the extent of £300,000 per annum. The Italian Government will also give S.A. preference when placing its annual contracts for beef for the Italian Army. The Minister of Commerce has explained that the Union Government is concerned at the small trade done by this country with East and West Africa, and believes the new arrangement will increase it, but the question is being asked why was the agreement come to with Italian companies without giving the British lines an opportunity of stating what they would be prepared to do for a subsidy of £150,000 per annum. The representatives of British firms state that they were never approached, and never heard anything about the matter until it was published in the Press. They also state now that they would have given what the Union Government required for a much smaller subsidy. Britain's re-export trade will suffer by the new arrangement.

Railway Electrification.

Sanction has been received at Durban from the Railway Board for work to begin immediately on the electrification of the railway track from Daimana to Harrismith, and it is anticipated that trains will be running over the line before the end of next year. The Administration's engineers have departed widely from precedent in many directions, and the economies contemplated will save many thousands of pounds. With the exception of cross-arms for the transmission line masts, everything will be made from scrap metal, and the main feature of the work is the total elimination of the enormous cost of running transmission lines across the country by the simple expedient of lengthening and strengthening the ordinary overhead equipment track masts. This will probably be the first occasion in the history of electric railways that so enormous a voltage as 88,000 volts has been carried on normal overhead equipment masts. The high-tension line on the Cato Ridge section of the line is 33,000 volts. The transmission current will be carried well out of reach of the overhead equipment, and tapped into sub-divisions, at which it will be transformed and converted to 3000 volts direct current. This will eliminate the enormous cost of fabricating transmission line masts to run across the country. Another outstanding feature is the departure from ordinary practice in the mast foundations. Instead of making concrete foundations on the spot, specially designed, pre-cast reinforced sleepers will be made at the Daimana depôt and set in position underground to receive the masts, which will simply be bolted into position. There will be a great saving by doing this.

Table Mountain Cableway.

The Table Mountain aerial railway, or cableway, has now been running for over three years, but although fairly well patronised it has certainly not been the success which the promoters of the enterprise anticipated. This is, of course, due to a great extent to the depression which had started before the cableway was well launched, and has continued up to the present, when it shows signs of lifting. When prosperity returns the cableway should speedily wipe out the loss that has been made and earn good profits, for there is no doubt that the view from the station on the top of Table Mountain is very wonderful, and will be an irresistible attraction to visitors from overseas, and just as much to residents in Cape Town and the Cape Peninsula. The span of the Table Mountain cableway is 4000ft., with a gradient of 17·5 per cent. The tension of the carrying cable is kept constant by counterweights at the lower station, and it is anchored at the summit by means of a concrete drum. This cable, on which the "cages" are suspended, is 1⅞in. in diameter and consists of 133 strands of wire rope. The cable is capable of bearing a weight of 120 tons. The cages weigh approximately 3 tons each. Each is suspended from the cable by eight rubber-tired wheels, and as it moves an automatic oiling system prevents rust and minimises friction. A 75 H.P. electric motor in the upper station provides the necessary haulage power, which is small, owing to the fact that the two cars connected to the same hauling cable are perfectly balanced. In addition to the carrying and hauling cable, an auxiliary cable is provided in case of emergency. This is connected to a separate motor of 35 H.P. There is also a 45 H.P. auxiliary petrol motor. The driver of the haulage machinery in the upper station has a clear view of the whole cableway, and can stop the machinery at a moment's notice. The conductor in each car can similarly bring his car to a stop in midair. When the ascending car is about 60 yards from the upper station a warning bell rings, and the controller at his observation post slows the car down to half speed. If, however, through negligence or emergency, he omits to do this, the car comes to a stop automatically 50 yards from the station. Telephonic communication between the two stations and the cars is effected by means of the haulage and carrying cables themselves.

New Railway Works.

A total sum of £4,376,662 has been allocated for new railway works for the year ending March 31st, 1934. Of this, £342,120 is for the construction of new lines, £1,034,867 for new works on existing lines, and £114,670 for the harbours. The balance is for various works and for new rolling stock. Railway traffic is reviving so rapidly that much new rolling stock and locomotives must be obtained. For the first four months of the current financial year there has been an increase in the railway receipts of nearly £1,000,000, compared with last year, the respective figures being £7,789,985 and £6,848,126. That the improvement continues is shown by the fact that the revenue for the week ended September 2nd was £486,181, which is more than £60,000 higher than the earnings during the corresponding week of last year.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

LIGHT ALLOY CASTINGS FOR AIRCRAFT PURPOSES.

The following new and revised British Standard Specifications for Light Alloy Castings have recently been published by the British Standards Institution :—

3 L 5.—Aluminium-Zinc-Copper Alloy Castings.
3 L 8.—12 per cent. Copper Aluminium Alloy Castings.
4 L 11.—7/1 Aluminium Alloy Castings.
2 L 24.—"Y" Aluminium Alloy Castings.
L 33.—Silicon-Aluminium Alloy Castings.
L 35.—"Y" Aluminium Alloy Castings (heat treated).

The principal revision consists in the substitution of test samples cast in dry sand moulds for those cast in chill moulds. The method of casting the test samples, the dimensions of the dry sand moulds and the tensile test figures required are specified. Corresponding tensile test figures which may be expected from the test samples if cast in chill moulds as formerly specified are added for information only.—Copies of these specifications can be obtained from the Institution, 28, Victoria-street, London, S.W.1, price 1s. 2d. each post free.

SAMPLING OF COAL.

No. 502—1933. This specification covers the new British Standard Method for the Sampling of Large and Run-of-Mine Coal. Hitherto the methods used have been somewhat empirical and, as a consequence, a high factor of safety has been employed resulting in very large gross samples. The British Standard Method follows in general principles the theory that was adopted as a basis for the Sampling of Small Coal, and recommends minimum sizes of samples based on the theory of errors, in which the size of the sample is directly related to the heterogeneity of the fuel and the degree of accuracy required. As a consequence, it has been found possible in the specification to recommend the adoption of much smaller sizes of gross samples than those previously taken.

The specification lays down the size of gross sample to be taken and the methods of collection and reduction to be used for coal from chutes, conveyors, and wagons, both riffle and the hand methods of reduction being described.

The Committee is unable to recommend a standard method for sampling from heaps that would be generally applicable, having due regard to the possible heterogeneous nature of the heap. A full account of the experiments and theoretical considerations which form a basis for the specification is included as an Appendix.

CREOSOTE FUEL.

No. 503—1933. This specification provides for creosote produced as a distillate of coal tar and it must be free from admixtures of petroleum oils, or undistilled crude tars. In view of the importance of maintaining fluidity it is required that the oil shall be free from organic acids, sediment or other impurities likely to choke the burners, and attention is also called to the fact that with some grades of creosote that are covered by the specification it will be necessary to provide warm storage and heated pipe lines. The specification includes requirements for the physical properties of the material, such as specific gravity, viscosity, water content, matter insoluble in benzole, fluidity, flash point, ash, and calorific value. Details as to the method by which the tests for the determination of these requirements are to be carried out are given in appendices to the specification.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Becco Engineering and Chemical Company, Ltd., has moved to Effingham House, Arundel-street, London, W.C.2.

William Firth and Co. moved on September 30th from 8, Hillary-place, Leeds, to 1, Lifton-place, Leeds, 2. The same telephone number and telegraphic address.

Mr. G. H. Brooke, assistant to the managing director of C. Akrill and Co., Ltd., West Bromwich, was on October 3rd appointed Secretary of the Staffordshire Iron and Steel Institute.

W. and T. Avery, Ltd., Birmingham, announce that Mr. P. H. Mills has been appointed managing director to succeed the late Sir Gilbert Vyle. Mr. Mills joined Avery's in 1919 and was appointed general manager in 1924. He joined the Board of Directors in 1927.

Herbert Terry and Sons, Ltd., Redditch, announce that Mr. J. A. Darby has been appointed sales manager at Redditch. He has been in the service of the firm for eighteen years, eight of which were spent in the eastern counties, where he will be succeeded by Mr. R. H. Chambers, who has been with the firm since 1919, and since 1927 has represented the firm in the North of England.

CONTRACTS.

Richard Crittall and Co., Ltd., of 43, Bloomsbury-square, London, W.C.1, have received an order for the destruction of the old chimney stack in Carnaby-street, London, W.1, a landmark in the West End belonging to the St. James and Pall Mall Electric Light Company, Ltd., and the equipment of the building with electric heating. The electrode boilers will be supplied by Bastian and Allen, Ltd., of 12 and 14, Church-road, Hanwell, London, W.7.

C. A. Parsons and Co., Ltd., Newcastle-on-Tyne, have received from Dominion Boxboards, Ltd., of Toronto, an order for an electrical generating set comprising a pass-out steam turbine coupled through gearing, both to a 1500-kW alternator and exciter and to a 250-kW direct-current generator. The turbine will run at 5500 r.p.m., and the electrical machinery at 1500 r.p.m. The set, which is of the "Uniplane" type, requiring no basement, will supply both three-phase current at 600 volts and direct-current at 500 to 70 volts.

Modern Factory Design.—Professor Maier Leibnitz, of the Technical High School in Stuttgart, gave a lecture on October 5th, at the headquarters of the British Steelwork Association on Modern Factory Design to a representative gathering of engineers. Professor Leibnitz was able to meet members of the Steel Structures Research Committee which was set up by the Department of Scientific and Industrial Research in co-operation with the British Steelwork Association, and he dealt with the direction of recent German research work in factory and steel-frame building construction. This research, he said, has brought to light many interesting advances, notably in the plastic theory of design, which has lead to a more rational utilisation of the elastic properties of steel construction. This was illustrated by tests carried out on continuous girders, which show that the stress transfer due to plastic qualities of steel have not hitherto been definitely evaluated. Professor Leibnitz illustrated this lecture with very notable examples of steel factory design, and dealt with the conditions which are essential to secure the best lighting conditions.

"Mavor and Coulson" Travelling Studentship.—The Council of the Institution of Mining Engineers has accepted a generous offer, made by Mavor and Coulson, Ltd., of Glasgow, of a sum of £300 for a further year, for a Travelling Studentship, which must include Canada or the United States of America in the itinerary of the selected candidate. The award will be made by the Council of the Institution on the recommendation of a Committee of Selection, and will be open to British subjects over twenty-two years and under thirty years of age who are Student Members, Associates, or Associate Members of the Institution of Mining Engineers, and who have graduated in Mining at a University, or hold the Diploma in Mining of an approved College or School of Mining, or who otherwise satisfy the Council that they have had a sufficient scientific training, and, in addition, must have had at least two years' underground experience in a colliery. The successful candidate will be required to devote one year to the special study by underground investigations of the methods practised in the actual mining of coal and in the transport of coal from the face to the main mechanical haulage; to follow a pre-arranged itinerary specifying the collieries to be visited, subject to the condition that not more than one month shall be spent at any individual colliery; at least one month shall be spent in Canada or in the United States of America; and a candidate who knows a foreign language may be required to spend not less than two months on work on the Continent of Europe. Full particulars may be obtained from the Secretary of the Institution at Cleveland House, 225, City-road.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Scrap Position.

The advance in the price of scrap iron and steel has been one of the outstanding features of the markets this year. For instance, basic steel scrap which at about this time last year was quoted at 35s. per ton, is not now easily obtainable at 42s. 6d. Sellers of most classes of scrap are reluctant to enter into heavy engagements, as they are finding it difficult to obtain supplies. Upon this subject, Mr. Joseph Ward, the chairman of Thos. W. Ward, Ltd., made some interesting remarks at the recent annual general meeting of the company. He pointed out that for a considerable time his firm had been warning the steel companies that the ridiculously low prices for scrap could not last as soon as there was a moderate increase in trade. It was the most important raw material in steel production, and could not be held down indefinitely below its economic value compared with pig iron and other raw materials. The firm had urged the importance of adopting some scheme to retain in this country the large weight of obsolete tonnage which was being sold abroad. As the steel works were at that time getting ample supplies of scrap at their own prices, they neglected to take any action. In the same speech he pointed out that the cheapness of scrap had had a serious effect upon shipbreaking and works dismantling operations, as to sell scrap at the low prices then offered by steel manufacturers, ships could not be purchased to allow for the heavy labour cost of demolition and transport, whilst at the same time there has been little inducement for owners of obsolete plant to put it on the market. Mr. Ward's remarks are appropriate to the position existing at the moment, as it is generally understood the steelmakers have an understanding amongst themselves as to the prices they will pay for their scrap supplies. These do not agree with sellers' views and something in the nature of a tug-of-war is in progress between the two sides of the market.

Pig Iron.

ALTHOUGH most of the large consumers of pig iron have covered their requirements a fair way ahead, some, in fact, into the first quarter of next year, there has been some rather brisk buying in this market during the past few days. Previously, there had been a spell of listless trading, but the firm tone of the market as a result of the rising tendency in the cost of raw materials like coke and ore has stimulated buyers to fill even their small needs in case an advance in pig iron prices takes place. On the North-East Coast it is stated that a proportion of the stocks remaining in the makers' hands have been sold, and as only two furnaces are producing Cleveland iron the output is not equal to the consumption. As a result the producers are less inclined to cut prices for export business and are not pressing sales in some of the outside districts. Current prices for Cleveland No. 3 foundry are 62s. 6d. d/d Teesside and 2s. more to consumers in the North-Eastern area; 65s. 3d. d/d Glasgow, and 62s. 3d. d/d Falkirk. Exports of pig iron from the Tees during September reached 13,862 tons, compared with 12,848 tons during August. Of this total only 4925 tons went to foreign destinations, compared with 4481 tons in the previous month. In the Midlands business has been somewhat irregular, and for the most part has consisted of small parcels. The demand has been principally from the light castings industry, but orders from the general engineering trades seem to be increasing in number and tonnage. Judging from the way the month has opened in this district it seems probable that the turnover for October will be in excess of that for September. In Scotland another furnace has been started up on hematite at the Govan Works, bringing the number of furnaces in blast in Scotland to nine. Of this total four are producing foundry, four hematite, and one basic iron. Business in East Coast hematite has been on a good scale for some time, and after showing considerable firmness prices have definitely advanced. The producers are unwilling to sell far ahead at the new prices, although, in some cases, buyers have offered contracts for delivery over the greater part of next year. The general price now may be called 60s. 6d. for No. 1 and 60s. for mixed numbers, f.o.b. and f.o.t.

Semi-finished Steel.

The chief characteristic of this market is the increasing tendency for quotations to advance. This is not surprising since practically all the British steel works producing blooms, billets, and sheet bars are well off for orders, and specifications are coming forward at a satisfactory rate. The competition experienced from the Continent has scarcely affected the position of the home producers. The Continental works are prepared to make special prices for the British market, dealing on its merits with each transaction, but, generally speaking, the quotations received cannot have been satisfactory to the foreign sellers. Orders amounting to several thousand tons go abroad each month, but the total trade in this material is, of course, very much smaller than before the import duties were imposed. In the inland markets Continental semis have only a restricted sale. Even in South Wales, where the Continent formerly sold considerable quantities of billets and sheet bars, the British works are in such a good position that they have been able to raise their quotation for sheet and tin-plate bars from £4 15s. d/d to £5 d/d. In this they have followed the example of the makers in other districts who, for some time past, have asked a premium of 5s. to 7s. 6d. on the official minimum prices of £5 for 500 tons and £5 7s. 6d. for 100 tons or less. It seems likely that before long the advances will be made official. Some makers, however, are reluctant to increase the official prices, although they no longer represent the figure at which business is being done.

Finished Materials.

The market in manufactured iron and steel is still irregular if the business passing and the works operations in the different districts are compared; but, on the whole, conditions appear to be generally improving. This is particularly noticeable on the North-East Coast, where preparations are being made to increase production. The steel works have a considerable amount of constructional work in hand, and the volume of general merchant business is expanding. The lack of good specifications from the shipyards is a disappointing feature of trade on the North-East Coast. In the Midlands most of the business passing has been on the small side; but the works are well employed and specifications against old contracts are coming in regularly. A considerable volume of business is passing in small bars, which are not subject to price control, and prices show an advancing tendency. For this reason probably a number of contracts have been placed lately for forward delivery, consumers evidently wishing to cover their requirements before prices appreciate further. A fair amount of business has gone to the plate mills lately, which were beginning to find conditions rather dull. There is a poor demand for boiler plates at the general quotation of £8 5s. For ship and tank plates the official quotation is £8 17s. 6d. The recently increased business in sheets has been well maintained, particularly for black sheets of the thicker gauges. For the first time this autumn some improvement has been noticeable in the demand for colliery materials, although the business is still far below the normal for this period of the year. In the Sheffield district several big contracts are in hand, and the general run of business is fairly satisfactory. The demand for stainless steel sheets is growing and the motor industry has been taking a considerable tonnage of alloy steel sheets. Export trading remains on the light side, but recently some fair business in tires has been taken from overseas markets. In South Wales business is fairly active, and although orders for tin-plates have fallen off in the last few weeks deliveries against contracts have been well maintained. Engineering firms in South Wales are moderately well employed, and are taking a fair amount of steel. It is noteworthy that the Whitehead Iron and Steel Company's works at Newport have lately found it necessary to work over the week-end. This company has secured a considerable volume of business in recent months in small bars and strip on home and overseas account.

The North and Scotland.

The activity in Lancashire is not so pronounced as it was a few weeks ago, but the lull is regarded as being of a temporary character. Consumers persist in purchasing their iron and steel requirements in small parcels. An active demand still exists for steel bars for bright drawing purposes, and it is probable that a considerable amount of business which used to go to America has been diverted by the duties to British works. Re-rollers of small steel bars are also meeting with a better call for their products than of late, and business in alloy steels has been well maintained. General engineering concerns are not really well off as regards orders, and their buying is spasmodic; but on the whole the demand from this source is increasing. It is unfortunate that the locomotive builders and the boilermakers continue to find conditions difficult, and as a result their call for boiler plates and similar materials is on a poor scale. In Scotland rather more cheerful conditions rule, and it is pointed out that if the Scottish shipyards are still passing through a period of depression they have been far busier than the shipbuilders in other districts in Great Britain. This year the total number of vessels launched at Scottish yards reached thirty-three, aggregating 49,000 tons. A number of the engine shops on the Clyde are busy and Wm. Beardmore and Co., Ltd., state they have more work in hand than for some years past. It is expected that the Orient Line will shortly ask for tenders for a new liner, and that the contract will be placed either on the Clyde or at Barrow. Nevertheless, at the moment the position at the Scottish steel works might be better, and contracts have been worked off quicker than new business has been placed. Until the shipyards are much busier, the demand for plates and sections cannot be satisfactory. On the North-West Coast the works are busy. The mills at Barrow and Workington are well employed on railway material and hoops, but fresh contracts would be welcomed.

Finished Iron.

Most of the British works engaged in producing bar iron have definitely improved their position during the past week or two, and business in this department seems likely to increase as the autumn demand develops. In the Midlands orders for the higher grades of bars are increasing in number, but business is principally for bars of the commoner qualities. Marked bars are quoted at £12 at users' works, and Crown bars at £8 10s. to £9 10s. Nut and bolt iron is quoted at £6 15s. to £7 10s., and as Continental material of similar quality is offered at about the same price, most of the business is going to home manufacturers. Business in Staffordshire marked bars has been on a more satisfactory scale of late; but there is still much idle plant. In Lancashire also there seems to be a revival in the demand for finished iron. Lancashire Crown bars are quoted at £9, with best bars at £9 10s. In Scotland the bar iron works are moderately well employed. Recently few contracts have been placed for forward delivery, but there has been a steady week-to-week demand. A certain amount of business has been done in iron for socket and fitting purposes. Most of the orders which have come to hand are for small parcels of a miscellaneous character; but now and again some fair-sized orders are taken for iron for railway purposes. Business in horseshoe iron remains steady, but shows little sign of expansion.

Ferro Alloys.

The market for ferro-alloys has revived of late although there is still much room for improvement. Most buyers have covered their requirements, and there is again a noticeable tendency in the market for transactions to be limited to hand-to-mouth quantities. Business in ferro-silicon has been on a good scale recently, but at the moment consumers appear to be in a hesitating mood. In ferro-chrome buying has fallen off slightly, but prices are still retained at recent levels. At the same time there are expectations that the prices of this alloy will be increased in the near future. The situation in the market for tungsten is interesting, and difficulties are experienced in obtaining adequate supplies of ore, owing to the attitude of the Chinese producers who, as reported recently in these columns, are restricting the quantities they offer. The price of this alloy has advanced several pence per pound since the beginning of the year, and if the ore position does not ease shortly further increases are expected. It is perhaps a good sign that some of the larger producers have covered their requirements up to and beyond the end of the year. The demand for cobalt is only moderate. Until recently a fair business was transacted in this alloy with the manufacturers of magnet steel, but this has now declined. The price of silico-manganese has become firmer, but at the same time buying has slackened and users appear to watch the market.

Copper and Tin.

The electrolytic copper market after a spell of moderate activity has again slipped back into a listless condition. This market is particularly sensitive to outside influences, and the progress of events in America and political affairs on the Continent have been adverse to an upward movement. Consumers in Europe have sufficient copper to carry on with, and prefer to buy from hand to mouth, and on a declining market rarely commit themselves far ahead. The shrinkage in values has not been noticeably heavy, but it has been sufficient to create a certain amount of nervousness amongst buyers. This, in turn, has been reflected in fresh weakness in the market. A short time ago the quotation for electrolytic went up to £39 5s.; since then it has eased to £37 10s., and at times producers have pressed forward sales. Latterly there has been some speculation in electrolytic copper, and dealers have bought fair quantities, the narrow margin between standard and electrolytic probably encouraging them to undertake these operations. Business in the standard market also has been on only a moderate scale, and prices have shown a weak tendency. Some of the selling in this market was probably due to speculators taking the view that the standard price was more likely to recede than the electrolyte was to advance. . . . . Lethargic conditions have developed in the tin market after the sharp burst of activity which followed the publication of the September statistics. Buying for industrial purposes has been light, both from America and from the Continent, whilst the tin-plate works in South Wales have not shown much interest in the metal. Heavy shipments of tin were made to the United States last week, and stocks in this country were reduced by over 1000 tons. It is expected that the October statistics will show a further decrease in the supplies.

Lead and Spelter.

Steady conditions have ruled in the lead market this week, and prices have fluctuated within a narrow margin. The buying which took place at the beginning of the month was not maintained, and the demand from consumers is still on a rather disappointing scale. The fact, however, that the manufacturers of lead products generally, and those of lead pipe and sheet in particular, are producing at a high rate is a satisfactory feature of the position. No doubt most of these consumers have stocks to draw upon, but at the current price the metal is sufficiently cheap to encourage replacement buying, and this the market seems to expect will make itself felt before long. Some buying which is attributed to purchases by investors who were content to wait some time for a return on their money is said to have taken place, but not on an important scale. The world's production of lead in August is estimated at 98,517 tons, and for the eight months ending August 31st at 816,625 tons. . . . The market for spelter seems to have entered upon an uninteresting phase. The demand is being maintained at a steady rate, but there is plenty of metal to meet all requirements, and prices have shown little change over the week. In one respect the market seems to be working back to the position which ruled some weeks ago when the demand in this country was much more active than on the Continent. The galvanisers here who bought fairly well a few weeks ago have shown little interest in the market lately. Remelted spelter is still in short supply and the price is stiffening. Statistically, the position seems to be gradually improving. American figures give the world's output of spelter for August as 99,895 tons and for the eight months as 686,906 tons.

The Fall in Steel Imports.

The striking effect of the tariff duties is reflected in the returns of iron and steel imports into the Tees presented at last week's meeting of the Tees Conservancy Commissioners. The figures showed that only 14,331 tons were unloaded in the river during the past eleven months, as compared with 119,067 tons in the corresponding period a year ago, and 24,563 tons in 1913–14. There was an increase in the importations during September compared with August, the respective figures being 2377 tons and 989 tons. This was chiefly due to the arrival of 1550 tons of sheet bars and billets, apparently some of the cheap material which was offered by Belgian manufacturers during August.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	2 19 6	2 19 6
No. 1	3 0 0	3 0 0
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
Midlands—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/9 to 17/–.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	5 15 0
„ Medium (0·42% to 0·60% C.)	6 12 6
„ Hard (0·61% to 0·85% C.)	7 2 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 25% C.), 500 tons and up	5 2 6
100 tons	5 10 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/3 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 17 6	7/–
„ „ 6 p.c. to 8 p.c.	£19 7 6	7/–
„ „ 8 p.c. to 10 p.c.	£18 17 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£29 15 0	9/–
„ „ „ 1 p.c. carbon	£30 17 6	10/–
„ „ „ 0·70 p.c. carbon	£35 15 0	12/6
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£18 0 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, October 11th.

	Home.	Export.
Copper—		
Cash	£33 5 0 to £33 6 3	
Three months	£33 8 9 to £33 10 0	
Electrolytic	£36 10 0 to £37 5 0	
Best Selected Ingots, d/d Birmingham	£37 10 0	
Sheets, Hot Rolled	£64 0 0	
Tubes, Solid Drawn (basis)	10¼d.	10¼d.
„ Brazed (basis)	10¼d.	10¼d.
Brass—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £34 0 0	
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£223 17 6 to £224 2 6	
Three months	£223 17 6 to £224 0 0	
Lead:	£11 16 3 to £12 3 9	
Spelter:	£16 10 0 to £16 15 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 13/–
„ Glasgow— Ell	12/6 to 14/–
„ „ Splint	14/6
Ayrshire—	
(f.o.b. Ports)—Steam	11/6 to 11/9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/– to 13/6
Unscreened Navigation	12/– to 12/6
Lothians—	
(f.o.b. Leith)—Hartley Prime	11/6 to 12/–
Secondary Steam	11/– to 11/6

ENGLAND.

Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/6 to 20/6
Furnace Coke		13/– to 17/6
Northumberland—		
Best Steams		13/6 to 14/–
Second Steams		12/6 to 13/–
Steam Smalls		8/6
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/6
Foundry Coke		17/– to 18/–
Sheffield—	Inland.	
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	8/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	17/9 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	19/– to 36/–
Furnace Coke	15/– to 17/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	10/– to 11/–
Steam Coals:	
Large	18/– to 20/6
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3⅛d.
Diesel Oil	3¾d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Public Works.

THE programme of national public works was first prepared with a view to utilising material supplied by Germany on account of reparations, and was modified in 1929 when reparations practically ceased and it was found necessary to make provision for work against the prospect of unemployment. Since then little has been done except to carry through works already in hand. Now the programme is being remodelled to be included in the general plan of financial and economic adjustment which the Government will submit at the reassembling of the Chamber of Deputies. It is understood that a sum of 20,000 million francs will be spent upon these works during the next five years. The money will be raised by a public loan, and the works must, therefore, be of a productive character, in the sense that they will be of direct benefit to the nation. Many of the undertakings included in the former plan are retained, notably the construction of motor roads similar to those being built in Germany and Italy, such roads radiating from Paris to Marseilles, Toulouse, Bordeaux, Le Havre, Lille, and Strasbourg. The rural electrification scheme will be completed, and the construction of fast ships for service between France and North Africa may be included in the list of works to be put in hand. Port authorities insist that preference should be given to harbour improvement works that were held up when no more reparation material was forthcoming. The powerful committee, backed up by the metallurgical industries, which is making strenuous efforts to induce Parliament to authorise the building of the Trans-Saharan railway, hopes that this enterprise will form part of the public works scheme. It is pointed out that while the railway may not be immediately productive, it is indispensable for the development of the African colonies and will largely pay for itself in the long run. There is, however, still hesitation in some quarters against accepting the railway as financially feasible. The suppression of level crossings and the carrying out of municipal and other schemes constitute a very long list from which the Government is making a selection. Whilst most of the proposed works will be of no immediate interest to the engineering and metallurgical industries, the extensive road-making scheme should necessitate the use of a considerable amount of machinery, although it is argued that works intended to provide employment should dispense with machinery as much as possible. The plan appeals to the public and to industrial interests as a possible means of stimulating general activity, but the expenditure on these works will constitute a mortgage on the country's future resources, unless it is assured of a sufficient return to cover the interest to be paid on the public loan. The financial attitude towards the scheme is one of extreme reserve.

Alcohol Motor Fuels.

The Government has issued a decree requiring that the alcohol-petrol fuel employed by commercial vehicle users shall be coloured by the addition of a chemical substance so that a mixture containing too high a percentage of alcohol shall not be foisted on private car owners. The heavy car fuel, with a content up to 25·9 per cent. alcohol, will be coloured rose by transparence with a yellow fluorescence. This is a result of the check which the authorities have sustained in their efforts to impose the use of a petrol-alcohol mixture in all motor cars. When the Government organised its historic Alcohol Circuit through the beet-growing districts in the north in the early days of the automobile industry, with a view to demonstrating the possibility of running vehicles on that spirit, it had in view the importance of being able to depend upon a home supply of liquid hydro-carbons in case of national emergency, and also of providing the agricultural industry with an unlimited outlet for the alcohol production which is a main factor of its prosperity. This idea of increasing the consumption of industrial alcohol was kept constantly in mind, and the matter was carefully investigated without any real advance being made until the State took over the purchase and sale of the spirit as a monopoly, when a huge accumulation of stocks showed the necessity of utilising them at almost any cost. All its attempts, however, to make the use of an alcohol-petrol mixture compulsory failed. The mixture was unstable; engines could not be started in cold weather, and pitting of valves, cylinders, and other engine parts was produced. An Office National de Combustibles Liquides was formed to investigate these and other liquid fuel problems. The results obtained were believed to be so completely satisfactory that a decree was issued two years ago requiring all petrol suppliers to add a percentage of alcohol to the mineral spirit, but the complaints of motorists led to a temporary withdrawl of the decree, although, when put into force again at the beginning of last summer, the same difficulties were experienced, so that the decree appears to have again failed in its object. So far as private cars are concerned, it is difficult to see how the alcohol mixture can come into general use when modern tendencies of automobile engine design are opposed to the conditions governing the combustion of alcohol. Motor car firms cannot design and build engines to run on a "national fuel" when they look to foreign markets for the sale of cars. It is true that the Office National affirms that a mixture of 20 per cent. alcohol with petrol will give better results than petrol alone with certain engine adjustments, but this has not been the experience of motorists who have tried the fuel and found it wanting. In the case of commercial vehicles a solution of the problem is found in the relative facility with which the heavier long-stroke engines usually fitted to them can be adapted to use the petrol-alcohol mixture. There has always been a distinction between fuels for private cars and commercial vehicles, the latter being supplied with a heavier and cheaper grade of petrol which influenced the design of engines and rendered it easier for users to adapt them to run on the new mixture. Even if the Office National des Combustibles Liquides should succeed in its efforts to eliminate the troubles complained of, there is still the question of cost. The State must supply the alcohol at cost, and even less, which explains why the State can alone achieve any success with the use of that spirit as a motor fuel.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

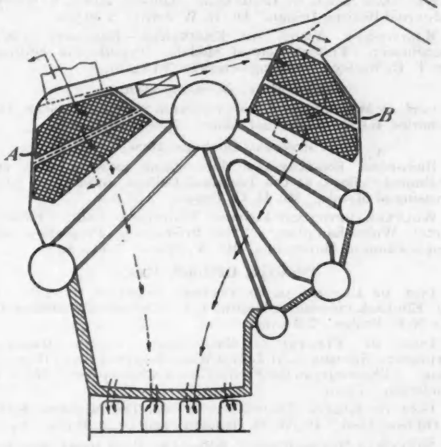
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

397,653. July 15th, 1932.—AIR PREHEATERS FOR WATER-TUBE BOILERS, H. E. Yarrow, Scotstoun, Glasgow.

It is claimed that this arrangement of an air preheater lowers the centre of gravity of the boiler. The heater is made in two sections A and B on opposite sides of the uptakes. The principal claim reads as follows:—In water-tube boilers having means for pre-heating the air for combustion in the furnaces of such boilers comprising substantially horizontal tubes on one or both sides of the boiler traversed internally by the air to be heated and externally by the furnace gases on their way to the uptake, the arrangement wherein the air pre-heating tubes on either side of the boiler are in two or more groups which are traversed in succession by the air to be pre-heated.—*August 31st*, 1933.

Nº397,653



INTERNAL COMBUSTION ENGINES.

397,742. December 19th, 1932.—LARGE TWO-STROKE GAS ENGINES, *W. W. Triggs, 57, Lincoln's Inn-fields, London, W.C.2.*

The inventors do not claim originality for the individual parts of this engine, but say by their proper combination a high-speed two-stroke gas engine can be contrived in large units. The gas is supplied by the compressor A and admitted to the cylinder by the cam-operated valves B B. The scavenging air is provided by the blower C and delivered to the cylinder through two central ports communicating with the passage D. The amount of air supplied at each stroke is 1·3 times the volume of the piston sweep. The exhaust ports are shown at E E. All four ports are covered and uncovered by the piston in pairs, two for the top of the cylinder and two for the bottom. It is emphasised that the admission of gas must start as soon as possible after the exhaust port is closed so that there will be ample opportunity for the gas and air to mix.—*August 31st*, 1933.

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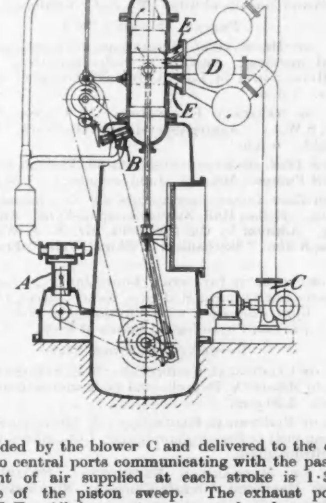

DYNAMOS AND MOTORS.

397,320. October 12th, 1932.—RADIO INTERFERENCE PREVENTIVE DEVICES, *Electrolux Ltd., of* 153–155, *Regent-street, London, W.*1.

The object of this invention is to provide an arrangement which prevents interference with radio installations operating on either short or long wave lengths, and is particularly applicable to series-wound motors driving domestic appliances. Two condensers A are arranged in the upper part of the casing and are directly connected across the brush holders B. A conductor C connects a point between the condensers A to the casing of the machine, which may be earthed. Inserted between the conductors D and E and outside the exciting coils of the motor is a third condenser F, which may be of large capacity. In the first condenser circuit, which includes the carbon brushes and condensers A, one or more fuses G may be arranged for the purpose of protecting the motor. Any interference caused by the sparking of the carbon brushes during running of the motor is, as far as short wave lengths are concerned, eliminated by the condensers A, while long wave interference is eliminated by the condenser F.—*August 24th*, 1933.

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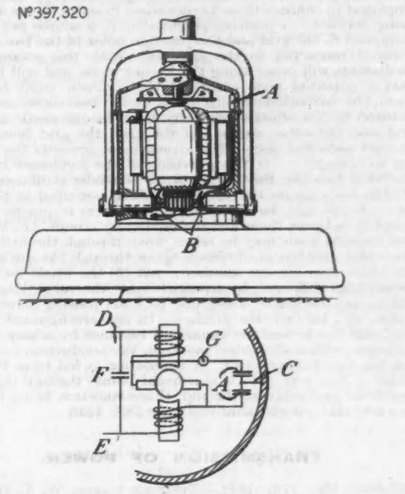

ELECTRICAL APPLIANCES.

397,438. May 3rd, 1933.—MEANS FOR PRODUCING ELECTRIC PEAK VOLTAGES, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, U.S.A.*

Arrangements are known for the production of electric peak voltages, wherein a considerably increased peak voltage is produced from a direct current or an alternating current voltage source by first charging condensers in parallel through ohmic resistances and then connecting them in series. It has been found that the additional stray capacities of the separate condenser elements with respect to earth have an unfavourable influence on the multiplication of the voltage, and the object of the invention is to overcome this defect. A indicates the spark gaps and B the condensers which, in combination with the spark gaps, produce the peak voltage. C is a string of insulators under test. D are high ohmic resistances, which are so graded that they have no influence on the peak process, but which allow the condensers to be charged in the given time. The connection of the current generating plant is effected at the points indicated by the arrows. The separate condenser elements E are constructed as cylindrical condensers and are arranged concentrically one with the other. The innermost condenser forms the highest potential stage and the outermost is connected to earth. The disturbing stray capacities of the separate condenser elements with respect to earth are thereby almost completely removed, so that the voltage loss which would otherwise be caused thereby is very greatly diminished.—*August 24th*, 1933.

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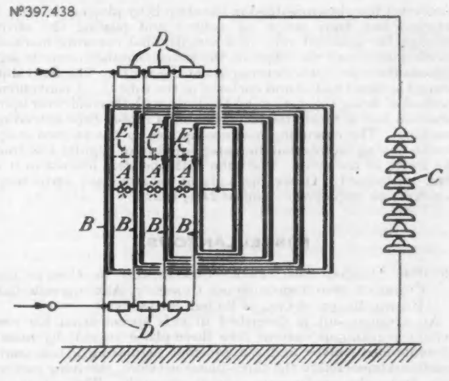

TELEGRAPHS AND TELEPHONES.

397,555. February 27th, 1932.—SHORT-WAVE OSCILLATION GENERATORS, Marconi's Wireless Telegraph Company, Ltd., of Marconi House, Strand, London, W.C.2, and Ernest Walter Brudenell Gill, of Merton College, Oxford.

The object of this invention is to provide an improved arrangement of short-wave oscillation generator, operated on the Barkhausen-Kurz principle, and wherein the action of the grid current tending to oppose oscillation is avoided. A thermionic valve, having a central straight cathode A, a cylindrical grid B surrounding the cathode, and a pair of part-cylindrical

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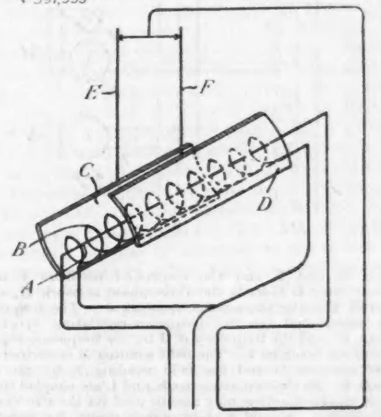

anodes C D are employed. It is found that to obtain satisfactory results with this construction of valve, the anode diameter should be not less than 2½ times the grid diameter. The two anode electrodes are connected together through a pair of Lecher wires E F in series, the large condenser ordinarily employed to connect these Lecher wires in series to one another being omitted. A positive potential from a source not shown is applied to the grid and the junction point of the two Lecher wires is connected to the cathode. With this arrangement oscillations will occur along the Lecher wires, and will be such that a potential node occurs at the junction point between them, the oscillations taking place in the two condensers constituted by the effective capacity between one anode and the grid and the other anode and the grid, the grid being thus another potential node. The arrangement presents the following advantages:—(1) The provision of the condenser hitherto provided between the Lecher wires is rendered unnecessary; (2) the leads inside the valve for taking potential to the grid and cathode may be so arranged that there is practically no coupling between them and the oscillatory circuit, *i.e.*, the grid and cathode leads may be taken down through the footstep of the valve and the anode leads taken through the envelope of the valve opposite one another; and (3) the whole oscillatory circuit can, if desired, be arranged inside the valve, thus eliminating any resistance losses due to leads passing through the valve, *e.g.*, through the pinches. In one arrangement of this kind the two anodes are connected together by a loop of wire arranged within the valve envelope, the conductors constituting the two Lecher wires. A connection is led from the mid point of this wire (which is a nodal point) through the valve envelope, preferably at the top, this connection being brought down to the cathode point.—*August 28th*, 1933.

TRANSMISSION OF POWER.

397,262. May 17th, 1932.—Electric Cable, W. T. Henley's Telegraph Works Company, Ltd., of 11, Holborn-viaduct, E.C.1; and John Henry Savage, of 13, Danson-mead, Welling, Kent.

This invention relates to the construction of cables which have a low electrostatic capacity. It has been recognised that a cable in which the wires are spaced well away from outside bodies and in which a considerable portion of the intervening space is filled with air will have a low capacity. According to the invention, a conductor A is embedded in a strip B of rubber of considerably greater width than the diameter of the wire and the strip is twisted about its longitudinal axis into the form shown. The twisted strip is enclosed in a rubber tube C. The conductor may be embedded in the strip B by placing the wire A between two thin strips of rubber and passing the strips through the grooved rolls of a longitudinal covering machine which compresses the edges of the strips together securely and embeds the wire in the centre part of the width. The strip thus formed is then twisted and enclosed in the tube C. A convenient method of doing this is to wind the strip with its conductor upon a bobbin and to rotate the latter behind a rubber tube extruding machine. The extruding machine applies to the twisted strip, a tube having an internal diameter equal to or slightly less than the width of the strip. The tube with the strip located in it is then vulcanised. Other methods of twisting the strip may, however, be employed.—*August 24th*, 1933.

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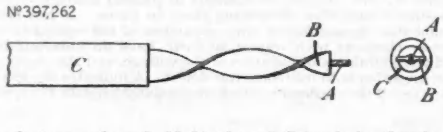

MISCELLANEOUS.

397,674. August 29th, 1932.—Conversion of Continuous Current into Three-phase Current, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

An arrangement is described in this specification for converting continuous current into three-phase current by means of controlled valves and a frequency regulating synchronous machine connected to the three-phase network, receiving current only from the continuous current network. The scheme is characterised by the feature that the three-phase network is divided into two parts, which receive their energy from separate converter groups, and that the frequency-regulating machines of both networks are mechanically coupled. In the drawing A is the continuous-current network: B and C the main continuous current switches of the two continuous current to three-phase current converters G, formed by the transformers D and F and the controlled rectifiers E and G. The converter D E feeds the three-phase network H, and the converter F G the three-phase network J. The frequency of H is determined by the frequency-regulating synchronous machine K, and the frequency of J by the frequency-regulating synchronous machine L. The field winding M is excited by the exciter machine O and the field winding N by the exciter machine P. As the two machines K and L are coupled together, a single exciter machine may also be used for the two synchronous machines. Should a short-circuit occur, for instance, in the network H, the machine K will, after the switch B has opened automatically, work as a generator on to the network H. The machine K will then be driven by L, which will prevent the speed of K appreciably dropping. When the faulty part of the network H has been disconnected, the switch B can be closed again without a dangerous current surge.—*August 31st*, 1933.

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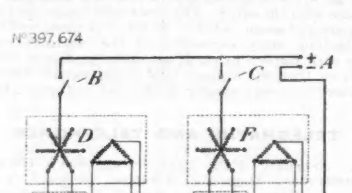

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME ***and*** PLACE ***at which the meeting is to be held should be clearly stated.***

To-day.

Inst. of Electrical Engineers: N.E. Students' Section.—Armstrong College, Newcastle-upon-Tyne. Chairman's address, "The Rating and Performance of Circuit Breakers," Mr. R. W. L. Harris. 7.15 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—Grosvenor Restaurant, Glasgow. "James Watt" dinner.

Inst. of Metals: Sheffield Local Section.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Centrifugal Casting of Non-ferrous Alloys," Mr. F. W. Rowe, B.Sc. 7.30 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "The Influence of Harmonics in Transformer Circuits," Mr. Ernest Ambrose, M.I.E.E. 7.30 p.m.

Keighley Assoc. of Engineers.—Queen's Hotel, Keighley. "Journal Bearing Design," Dr. H. W. Swift. 7.30 p.m.

Manchester Assoc. of Engineers.—Engineers' Club, Manchester. Presentation of Medals. Presidential address, Dr. T. B. Morley. Smoking concert. 7.15 p.m.

Saturday, October 14th.

Inst. of Marine Engineers: Junior Section.—85–88, The Minories, E.C.3. Social and dance. 7.30 to 11.15 p.m.

Monday, October 16th.

Bradford Engineering Soc.—Joint meeting with the Technical College, at the Technical College, Bradford. "Degreasing of Metals," Mr. H. O. Brown. 7.30 p.m.

Wolverhampton and District Engineering Soc.—Victoria Hotel, Wolverhampton. "The Production, Properties, and Applications of Aluminium," Mr. W. Tyson. 7.30 p.m.

Tuesday, October 17th.

Inst. of Electrical Engineers: Scottish Centre.—At 39, Elmbank-crescent, Glasgow, C.2. Chairman's address by Mr. N. C. Bridge. 7.30 p.m.

Inst. of Electrical Engineers: South Midland Students' Section.—At James Watt Memorial Inst., Birmingham. "Electricity in the Production of a Newspaper," Mr. J. R. Anderson. 7 p.m.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. "Oil from Coal," Dr. W. R. Ormandy and Dr. J. Burns. 6 p.m.

Sheffield Metallurgical Soc.—198, West-street, Sheffield. "Exhaust Valve Failures," Mr. C. C. Hodgson. 7.30 p.m.

Wednesday, October 18th.

Inst. of Electrical Engineers: South Midland Centre.—Grand Hotel, Birmingham. First general meeting. Chairman's address, Mr. J. Coxon. 6.50 p.m.

Inst. of Fuel.—In the Lecture Hall of the Geological Soc. of London, Burlington House, Piccadilly, W.1. Presidential address by Sir Wm. J. Larke. 11.30 a.m. "Recent Developments in Coking Practice," Dr.-Ing. H. Koppers. 2.30 p.m. Connaught Rooms, Great Queen-street, W.C.2. Annual dinner and dance. Presentation of the Melchett Medal to Sir John Cadman. 6.45 for 7.15 p.m.

Inst. of Locomotive Engineers (London).—Dudley Room, Queen's Hotel, Birmingham. Presidential address, "Colonial Railways," Major Charles E. Williams. 7 p.m.

Inst. of Production Engineers: Birmingham Section.—At James Watt Memorial Inst., Gt. Charles-street, Birmingham. Discussion, "Unusual Production Processes," Opener, Mr. G. H. Wray. 7 p.m.

Royal Microscopical Soc.—B.M.A. House, Tavistock-square, W.C.1. Meeting at 5 p.m.

Thursday, October 19th.

Inst. of Production Engineers: Glasgow Section.—At 39, Elmbank-crescent, Glasgow. "Survey of Latest Engineering Materials and Machineability," Mr. A. C. Macdonald. 7.30 p.m.

Friday, October 20th.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting; election of Sub-committee. Discussion, "The Horse-power of Locomotives," introduced by Mr. A. G. Hopkins. 7 p.m.

Inst. of Sanitary Engineers.—At Caxton Hall, Westminster, S.W.1. "Aggregates for Concrete Work," Dr. Bernard H. Knight. 6 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "Air Lift Pumps," Mr. A. C. Judd (member). 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. Annual general meeting. Address by the President, Mr. R. J. Walker; cinematograph film, "Mechanism of Ships' Wake," Professor T. B. Abell.

Soc. of Chemical Industry (Food Group).—London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, W.C.1. Joint discussion with Physiological Soc., "Diet from the Chemical and Physiological Points of View." 8 p.m.

Saturday, October 21st.

Inst. of Electrical Engineers: N.E. Students' Section.—Visit to Messrs. A. Reyrolle and Co.'s short-circuit test plant, Hebburn. 2.30 p.m.

Inst. of Electrical Engineers: S. Midland Students.—Afternoon visit to *Birmingham Gazette*, Ltd., offices, Corporation-street, Birmingham.

Inst. of Mechanical Engineers: Graduates.—Visit to the de Havilland Aircraft Company, Stag-lane Aerodrome, Edgware.

Tuesday, October 24th.

Inst. of Automobile Engineers.—At Hotel Victoria, Wolverhampton. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow, C.2. "Flame Cutting of Steel for Welded Joints," Mr. E. J. Clarke. 7.30 p.m.

Sheffield Metallurgical Soc.—198, West-street, Sheffield. "Our Knowledge of the Conditions in the Blast-furnace," Mr. R. C. Tucker. 7.30 p.m.

Wednesday, October 25th.

Inst. of Mechanical Engineers: Yorkshire.—Grand Hotel, Sheffield. "Fatigue and Corrosion Fatigue, with Special Reference to Service Breakages," Prof. Frederic Bacon. 7.30 p.m.

Thursday, October 26th.

Glasgow University Engineering Soc.—At James Watt Engineering Laboratories, University. Presidential address by Mr. H. A. Reincke. 7.30 p.m.

Inst. of Electrical Engineers.—Savoy-place, W.C.2. Presidential address, Mr. P. V. Hunter. 6 p.m.

Inst. of Mechanical Engineers.—At Dorchester Hotel, Park-lane, W.1. Annual dinner, 6.45 for 7.15 p.m.

Inst. of Mechanical Engineers: Yorkshire.—Queen's Hotel, Leeds. "Fatigue and Corrosion Fatigue, with Special Reference to Service Breakages," Prof. Frederic Bacon. 7.30 p.m.

Midland Metallurgical Societies.—In the James Watt Memorial Inst., Gt. Charles-street, Birmingham. Discussion, "The Production of Sound Cast Iron Castings." 7 p.m.

Friday, October 27th.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. General meeting. Presidential address, Mr. Alan E. L. Chorlton. 6 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "The Electrolytic Theory of Corrosion," Mr. H. E. Yerbury, M. Inst. C.E., M.I. Mech. E., M.I.E.E. 7.30 p.m.

Saturday, October 28th.

Stephenson Locomotive Society.—Visit to Stratford, L.N.E. Railway Running Sheds. 2.30 p.m.

Monday, October 30th.

Bradford Engineering Soc.—Technical College, Bradford. "Salvage Work on the Ex-German Fleet at Scapa Flow," Mr. E. F. Cox. 7.30 p.m.

Inst. of Automobile Engineers.—At 39, Elmbank-crescent, Glasgow. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Stainless Steels in Aeroplane Structures," Mr. F. J. Murdoch. 6.45 p.m.

Tuesday, October 31st.

Inst. of Transport.—15, Savoy-street, W.C.2. Discussion, "The Duties of a Modern Transport Manager," Mr. M. F. Barnard.

Thursday, November 2nd.

Inst. of Automobile Engineers.—Queen's Hotel, Birmingham. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 8 p.m.

Friday, November 3rd.

Inst. of Marine Engineers.—Grosvenor House, Park-lane, W.1. Annual conversazione. 7 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Thomas Hawksley Lecture, "Kinematic Design in Engineering," Professor A. F. C. Pollard. 6 p.m.

Railway Club.—57, Fetter-lane, E.C.4. "Train Ferries: Their History and Development," Mr. S. R. Yates. 7.30 p.m.

Friday, November 10th.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Discussion, "Financing Industry," introduced by Mr. Sydney Parkes. 7 p.m.

Monday, November 13th, to Saturday, November 18th.

Public Works Congress and Exhibition.—Agricultural Hall, Islington, N.1. Daily.

Thursday, November 16th.

British Waterworks Assoc.—Agricultural Hall, Islington, N.1. To receive and discuss the following papers:—"Pooling of Supplies by Interconnection of Water Undertakings and their Trunk Mains through Rural Areas," Mr. Alan E. L. Chorlton; "Water Pollution Research," Dr. A. Parker. 11 a.m. Afternoon session: "The Financial Management of Municipal Trading Departments," Mr. Sydney Larkin; "Water Supply and Fire Protection," Mr. John Smith; "Fire Prevention and Fire Extinguishing Apparatus," Major F. W. Jackson; "The Legal Aspect of Water Supply for Fire Protection Purposes," Mr. John Hall. 2.45 p.m.

Tuesday, November 28th.

Inst. of Electrical Engineers: Scottish Centre.—Grosvenor Restaurant, Gordon-street, Glasgow, C.2. Annual dinner and ladies' evening. 6.30 p.m. for 7 p.m.

LAUNCHES AND TRIAL TRIPS.

Port Chalmers, twin-screw motorship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Commonwealth and Dominion Line, Ltd., of London; dimensions, 486½ft. by 65¼ft.; to carry cargo. Oil engines, of Barclay-Curle Doxford Diesel type; constructed by Barclay, Curle and Co., Ltd.; launch, October 3rd.

Baron Elgin, steel screw steamer; built by D. and W. Henderson and Co., Ltd., to the order of Messrs. H. Hogarth and Sons, Glasgow; dimensions, 365ft. by 51ft. 6in. by 26ft.; to carry cargo. Engines, triple-expansion, pressure 210 lb. per square inch; constructed by the builders; trial trip, October 4th.

Sir Russell, single-screw, self-trimming collier; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Stephenson Clarke and Associated Companies, Ltd., London; dimensions, 252ft. by 36½ft. by 18ft.; to carry coal. Engines, triple-expansion, 19in., 31in., 51in. diameter by 36in. stroke, pressure 180 lb. per square inch; constructed by the builders; launch, October 4th.

Prabhavati, twin-screw steamer; built by Harland and Wolff, Ltd., to the order of the Bombay Steam Navigation Company; dimensions, 199ft. by 34ft. by 11ft. 6in.; to carry cargo and passengers. Engines, triple-expansion; constructed by the builders; trial trip, recent.

Water Softeners at St. Helens.—After the "Permutit" water softeners at the St. Helens new water purification plant at Sutton-road, opened on September 28th, have passed 25,000 gallons of water per hour for several hours, the Base-Exchange bed becomes exhausted and requires complete revivification, which operation is called regenerating. The process of regeneration is effected by passing through the softeners a solution of common salt or sodium chloride. The effect of this solution on the bed of Base-Exchange material is to remove the calcium and magnesium salts, which leave the plant in the form of calcium and magnesium chloride, *i.e.*, a perfectly clear solution. The sodium of the sodium chloride replaces the sodium in the Base-Exchange material, thus leaving the bed completely revivified. St. Helens, for this particular operation, has a design which is quite unique, inasmuch as instead of the salt for each regeneration having to be weighed out carefully, taken to its salt tank, and mixed with water, the supply necessary for a week or ten days can be stored in such a way that the saturated solution is always ready by merely opening a valve. Added to this saturator there is a storage compartment containing complete storage of saturated brine ready for passing to the measuring tanks whose volume is such that it represents the exact quantity required to regenerate the units. Very careful safeguards are provided to ensure that the specific gravity in each of the brine compartments is as exactly required. Another interesting feature about this section of the plant is the fact that in order to ensure the utmost economy in brine, after the solution has been used once, it is returned to a compartment known as the "old brine compartment," and at the next regeneration is used again before being passed down the drain.

A Seven-Day Journal

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Car Prices and Road Accidents.

Speaking at the annual dinner of the Motor Agents' Association on Monday last, Sir Herbert Austin said that a drastic reduction in the selling costs of cars should be undertaken at once, and that the first step ought to be the cutting out of at least half of the people at present receiving agency terms. Economic conditions did not admit of a reduction in prices to-day without a decrease in the quality, and nothing in the world could do the British motor car industry greater harm than to reduce quality. He saw no likelihood of any reduction in prices at the present time, and thought it would be a great pity if any attempt was made by any firm to cut prices. Lamenting the number of deaths from road accidents, he said that he had had a long talk with the Minister of Transport, and he was very much afraid that, if means were not discovered for the reduction of the total number of such accidents, the old speed limit would return. That would prove an enormous setback to the trade. All associated with the industry, particularly agents, ought to do everything they could to get clients to appreciate the danger there was of a return to the old speed limit, and to impress upon them the necessity of careful driving.

A Powerful Ocean-going Tug.

The new motor tug "Zwarte Zee," which last week completed her official speed and power trials, and will be stationed at Brest during the winter months in the service of L. Smit and Co.'s Internationale Sleepdienst, is stated to be the most powerful ocean tug towing, and salvage, vessel afloat. She was built at the Kinderdijk yard of Smits Machinefabrieken, and was engined by the Werkspoor Company, of Amsterdam, and has a length of 59·7 m., a beam of 9·7 m., and a depth of 5·9 m., with a registered tonnage of 792 gross tons. The propelling machinery comprises two Werkspoor oil engines, with a total of 4200 H.P., which drive the single propeller through mechanical gearing, and a Vulcan hydraulic coupling. When running free, a speed of 17½ knots is attained. A specially large bunker capacity for a round-the-world trip without bunkering has been provided. The navigation equipment includes wireless telegraphy with direction-finding equipment, and other modern navigating instruments and fittings. As the tug may be called upon to act as a salvage vessel, a very complete salvage equipment has been included. It comprises not only fire-fighting apparatus, but diving gear and salvage pumps of large capacity. The new tug has a short, squat funnel, which gives her an individual appearance.

Shipbuilding Employers' Federation.

The annual general meeting of the central board of the Shipbuilding Employers' Federation took place in Edinburgh on Thursday, October 12th, when Mr. G. Tristram Edwards, the assistant managing director of Smith's Dock Company, Ltd., of North Shields, Middlesbrough and Stockton, was elected President for the ensuing year in succession to Mr. J. B. Hutchison, of Scott's Shipbuilding and Engineering Company, Ltd., of Greenock. The re-elected Vice-presidents are Mr. C. S. Swan, of Swan, Hunter and Wigham Richardson, Ltd., and Mr. Maurice E. Denny, of William Denny and Brothers, Ltd., of Dumbarton. Mr. F. E. Rebbeck, the chairman of Harland and Wolff, Ltd., Belfast, was also elected a Vice-president to fill the vacancy caused by the election of Mr. Tristram Edwards as President. Mr. H. Main, of the Caledon Shipbuilding and Engineering Company, Ltd., of Dundee, was appointed chairman of the Conference and Works Board of the Federation, with Mr. F. C. Mullens, of the Port Talbot Shipbuilding and Graving Dock Company, Ltd., Port Talbot, as vice-chairman. On Friday of last week, the Federation met representatives of the shipyard trade unions and discussed the proposals to create a separate class of electric welders for shipyard work. Both sides considered the matter carefully, but it was declared impossible by the shipyard unions' representatives that the unions would agree with the employers' proposals, and the whole matter was finally referred to the arbitration of the independent chairman, Mr. T. Graham Robertson, K.C., who, it may be recalled, succeeded Lord Macmillan in that capacity some three years ago.

Beauty in Machinery.

On Friday, October 13th, Dr. T. B. Morley delivered his inaugural address as President of the Manchester Association of Engineers. In it he dealt with what engineers might do to decrease the nuisances they have created and to augment the amenities of life. We quote from it the following interesting passage :—"No true engineer and no true craftsman is content to despise mere appearances. Our predecessors tried to beautify their work by the addition of ornamentation. One finds old beam engines with fluted cast iron columns with capitals in imitation of carved stonework. I am thankful that taste to-day abhors such inappropriate and functionless adornment and follows the simpler standards of good proportion and adaptation to purpose. Admittedly, that quality in a machine or engine that can have any claim to the term beauty takes a trained mind for its discernment. Undoubtedly, however, there is something not unworthy of that name in a structure or mechanism in which the parts are well proportioned and well finished, and in which the whole is in harmony and reveals the underlying principle of fitness to purpose. The designer and the draughtsman may justly take pride in fitness and cleanness and harmony of design, though it is as impossible to define what those terms mean as it is to describe a sunset to a man born blind. Perhaps the best illustration of their meaning is afforded by the want of harmonious design shown by certain locomotives, which look as if the designer had simply stuck accessories round the primary design in a way that suggests they were all afterthoughts and he had not taken the trouble to remodel the primary design to accommodate them in a pleasing manner. But design is not all. Let the man in the shops take pride—and may he have the chance to do so—in sound workmanship and neat finish. Minor details can make or mar appearance. Oil pipes that are wavy and laid at all sorts of angles will carry oil to lubricating points quite effectively, but what a difference it makes to the look of an engine when the oil pipes are run neatly in straights and evenly curved bends, in lines that conform to the lines of the engine."

A Steel Firm's Jubilee.

The firm of H. J. Skelton and Co., Ltd., iron and steel merchants, Royal London House, Finsbury-square, London, E.C.2, celebrates its fiftieth anniversary this month, having been founded in 1883. Even in those distant days the founder, Mr. H. J. Skelton, had achieved a position in the British iron and steel trades, although he had previously been connected with the works side of the business. Under his guidance the firm became known as one of the most enterprising merchant houses in the steel trade. Amongst the contracts it handled was the supply of the steel for the hull of the Dreadnought "Thunderer," the last battleship to be built on the Thames. It also provided the steel for the Boulac and Embabeh bridges in Egypt, which were erected by French and Belgian builders, but constructed of British steel. This was largely due to the initiative of the firm in giving the builders an all-round price in their own currency delivered at their works, and in covering them for a period. Another outstanding transaction was the purchase from the Government Disposal Board of the whole of the British Admiralty stock of steel for fabricated ships, amounting to 66,000 tons, at a price of over £1,000,000. On another occasion the Crown Agents for the Colonies permitted the firm to supply rails for the Gold Coast Railways without inspection, thus putting upon a merchant firm the onus of supplying materials of suitable quality. Mr. H. J. Skelton has retired from the business for the past few years, but his work in connection with the British Engineering Standards Association—now the British Standards Institution— and in many other directions will stand as a reminder of a forceful and likeable personality.

British Exports.

The oversea trade returns published last Friday make cheerful reading, as they fully confirm the general impression that industry is rising from the deepest trough of the depression. Compared with the corresponding month—September—last year, the value of British exports rose by the substantial figure of nearly £6,000,000, the total for this year being £32,226,287. Treated from the engineer's standpoint, it is gratifying to find that out of the total increase no less than £4,981,000 was due to manufactured goods in general. No single group of manufactured goods showed a decline, while such important industries as the iron and steel, non-ferrous metal, machinery and textiles, all showed substantial improvement. This country, comparatively, exports but few raw materials. But coal, which is by far the most important of our exports falling under this category, accounts for nearly one-half of an increase of £875,000. That the expansion in the export trade is still continuing appears to be indicated by the increase of £1,230,000 in exports in September over those of the preceding month. This expansion, too, was spread over a large number of groups.

Tramp Shipping.

The Chamber of Shipping announced at the end of last week the *personnel* of the special committee which it has invited to serve under the chairmanship of Mr. R. J. Dunlop, of Glasgow, to investigate fully the present position of British tramp shipping. The committee is a strong one and is fully representative of different shades of opinion. Its work will be to examine fully all questions bearing on the present plight of the industry, including the subsidising of foreign shipping. It will also consider possible remedial measures, such as the laying up of ships and scrapping programmes to be carried out either with, or without, Government support. It may be recalled that the Chamber of Shipping freight index number for last month was only 70·73, compared with 100 as the average of the general index numbers for 1913. The present figure is the lowest recorded since 1920, when the recording of index numbers was first begun by the Chamber. It is expected that the committee which has been appointed will meet as soon as the material prepared for its consideration is ready. In due course it will report to the Council of the Chamber of Shipping, of which Mr. W. T. McAlister, the chairman and managing director of the General Steam Navigation Company, Ltd., is the President.

The Galloway Power Scheme.

By the clearing of the final barrier in the Glenlee Tunnel on Tuesday, October 10th, another stage in the harnessing of the water power resources of Southern Scotland for the service of industry was reached. Lord Meston, chairman of the Galloway Water Power Company, presided at the "break through" ceremony, and Sir Andrew Duncan, Chairman of the Central Electricity Board, fired the final round of explosives. The construction of the tunnel, which is an important part of the scheme, is being carried out by Mr. A. M. Carmichael, works contractor, Edinburgh. In welcoming Sir Andrew Duncan, Lord Meston explained that the tunnel, which was 3½ miles long, would carry the water from a new reservoir to the hydro-electric station at Glenlee, and that the complete scheme would provide power for Southern Scotland and the great industrial areas of Glasgow. The work had moved towards the general well-being of Great Britain and that would be remembered when kindly Nature had covered up the scars the engineers had been forced to make on the countryside. In replying, Sir Andrew Duncan congratulated the contractor on the excellence of his work. Subsequently Mr. Carmichael explained that in the process of breaking through the rocks 200 tons of explosives and 150,000 detonators had been used without a single fatal or serious accident. The work had been hard, difficult, and dangerous, but the men engaged upon it had given of their best. He also congratulated the sub-contractors, including Nobels Explosives, the Consolidated Pneumatic Tool Company, which supplied all the rock drills, and the Sullivan Machinery Company, which was responsible for the scrapers for removing the *débris*.

The Late Hon. Lady Parsons.

It is with deep regret that we have to record the death of the Hon. Lady Parsons, which took place at her home at Kirkwhelpington, Northumberland, on Monday last, October 16th, after a long illness. Lady Parsons, who married the Hon. Sir Charles Parsons in 1883, was deeply interested in her husband's many occupations, and in particular she sponsored the work of women in the engineering industry. She was one of the founders of the Women's Engineering Society, and when, in 1920, eight girls started the engineering business of Atalanta Ltd., in South London, she assisted the new enterprise and took a keen interest in the firm. She is survived by her daughter, Miss Rachel Parsons, who passed through the Cambridge University engineering school, and during the war served in the training department of the Ministry of Munitions.

An Oil-Electric Tug for Thames Service.

Throughout the present week daily demonstration trials have been carried out on the Thames, with the new oil-electric tug "Lectro," which has been specially constructed for the Shell-Mex B.P. oil barge towage service of the Union Lighterage Company, Ltd., of London. In the building of the tug Henry Robb, Ltd., of Leith, shipbuilders, Mirrlees Bickerton and Day, Ltd., of Hazel-grove, Stockport, and the British Thomson-Houston Company, Ltd., of Rugby, co-operated. An outstanding feature of the design is the direct control of the engines and the propulsion motor from the bridge. We attended the trials carried out on the Barking Reach on Tuesday, October 17th, and witnessed for ourselves the remarkable manœuvring capabilities of the tug. She has an overall length of 92ft., a beam of 22ft., a depth of 11ft. 6in., and a forward draught of 7ft. 6in., with an after draught of 11ft. 9in. There are two six-cylinder, 360 B.H.P. Mirrlees airless injection engines, which are direct-coupled to 250-volt D.C. compound-wound B.T.H. main and auxiliary generators running at 300 r.p.m. The generator output is designed to meet the full power requirements of a 580 S.H.P. motor operating at 500 volts with a speed range of 120 to 150 r.p.m. The two 20 kW auxiliary generator sets furnish power for excitation and ship's auxiliaries. The bridge control includes two stations of the standard bridge telegraph type, which are mechanically connected one with the other and operate the electrical control gear, which governs the running of the engines. We operated for ourselves the controls and found them easy, with a quick response of the machinery. The tug will be shortly commissioned, when it is expected that a full record of her performance will be available for publication.

The Hoover Dam on the Colorado River.

No. I.

The great Hoover Dam* project has gone steadily forward since we dealt with the subject in our issues of December 9th and 16th, 1932. Notwithstanding the unprecedented magnitude of the undertaking, work in certain particulars is several months ahead of the schedule which was agreed upon when the general contract was awarded to Six Companies, Incorporated, on March 11th, 1931. If the present pace be maintained, it is probable that water will be passing through the turbines a year sooner than was originally planned. The progress so far made is attributable to the energy and resourcefulness of the Six Companies' organisation and to the whole-hearted collaboration of the Bureau of Reclamation of the Federal Government. The Bureau of Reclamation, since it was called into being thirty-one years ago, has accumulated a vast fund of experience and technical data which has been drawn upon in developing the plans for the Hoover Dam and its associated features.

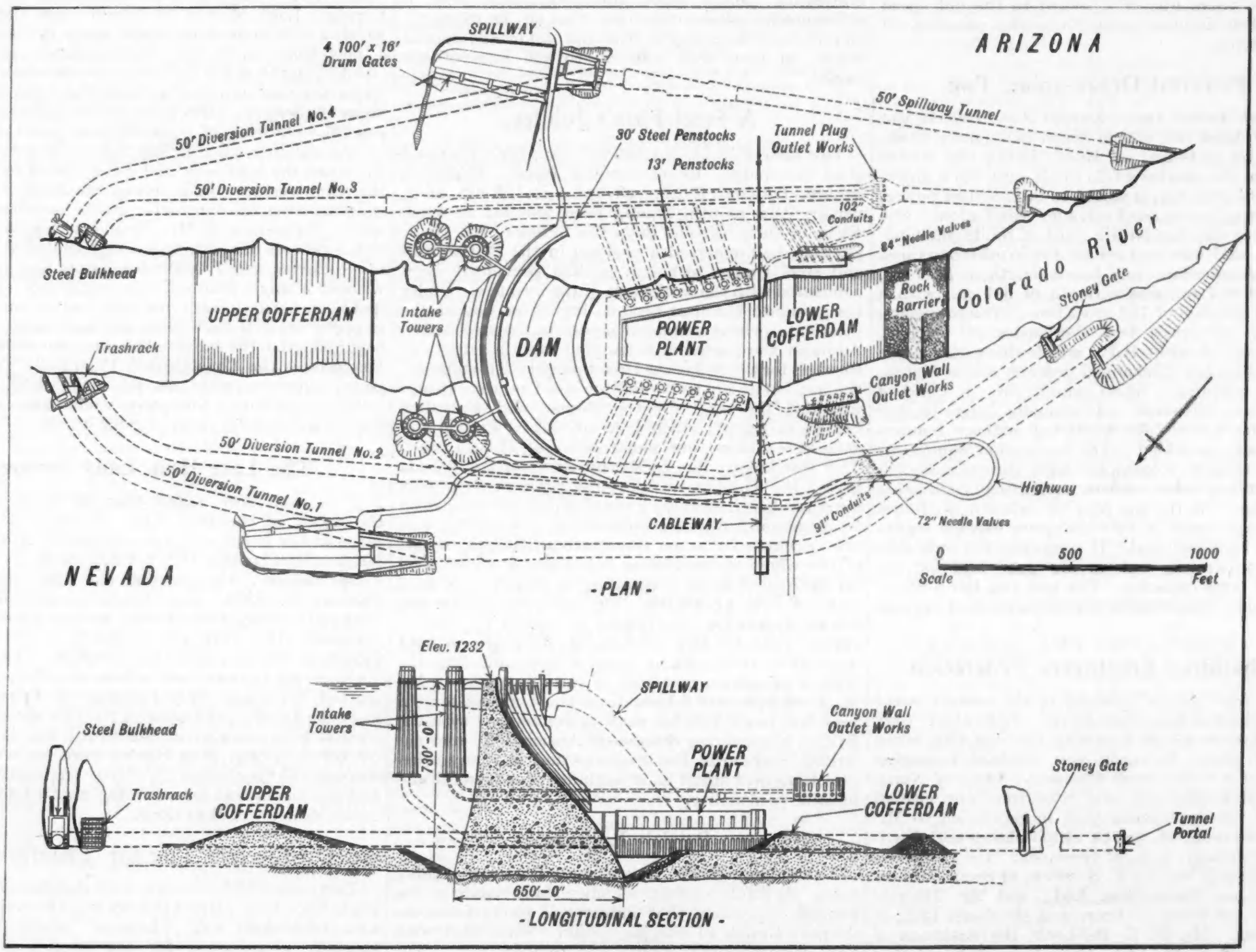

Fig. 1—General Plan and Section of the Hoover Dam as Finally Modified

We concluded our previous notice by referring to the advanced stage reached in the work of lining the four 50ft. diversion tunnels. On November 13th and 14th last Diversion Tunnels Nos. 3 and 4—see Fig. 1—were ready to receive the diverted flow of the Colorado River. On these two days large blasts of dynamite cleared away the barriers at the inlet portals of the two tunnels. The admission of water to Diversion Tunnels Nos. 3 and 4 marked the climax of the preparatory work covering a period of a year and a-half. The barriers blown away were portal cofferdams constructed to protect the diversion tunnels from inundation in the event of a high-level flood occurring before the tunnels were ready for service.

Early in the preceding September a spur dump, formed of material from the adjacent tunnel excavations, was extended out from the Nevada wall of the canyon until it reached midstream, the spur being started from a point a short distance downstream from the intake portals of Diversion Tunnels Nos. 1 and 2. This spur, made by end dumping from motor trucks, was then continued downstream, roughly parallel with the shore line for fully 700ft. and then turned at right angles back to the Nevada side of the canyon. The enclosed area, which was shortly afterwards unwatered, covered half the site for the main or upstream cofferdam that was completely to block the river and divert any probable flood through the four tunnels. Besides crowding the stream to the Arizona side of the canyon, this temporary barrier enabled part of the river bed to be cleared for the purpose of reaching a suitable foundation for the upstream cofferdam. A 5 cubic yard electric dragline and a number of 3½ cubic yard electric shovels, with a fleet of motor trucks, were set to work excavating the exposed river bed. This work was continued down to a depth of 18ft., through silt and sand, when a stratum, composed of an admixture of sand, gravel, cobbles, and boulders, was reached. This stratum was deemed amply stable for the desired foundation and was at a point 98ft. below the crest of the prescribed cofferdam—that is, at elevation 622ft.

Immediately after water was admitted to the two Arizona diversion tunnels operations were started a short distance downstream from those intakes to extend the initial spur, forming the upper end of the temporary barrier, so as completely to block the bed of the river and to send all the water through the two diversion tunnels. A timber trestle bridge extending to the Arizona side of the canyon was used as a means to this end, and from it motor trucks dumped material on both sides. Within thirty hours following the initial diversion of the river the temporary dam had been raised high enough to send the entire flow of the river into the two available tunnels. This closure having been effected, the unwatering of the remaining half of the site for the upstream cofferdam was begun. Seepage through the temporary barrier was checked by widening and heightening it with material removed from the cofferdam site. Shortly after the bed of the river was blocked in this manner a corresponding barrier was formed just upstream of the diversion tunnel discharge portals. These works concluded the preparations leading to the construction of the upper and lower cofferdams that were to make possible the subsequent excavation of the rock underlying the site of the Hoover Dam.

The Upper Cofferdam.

The upper cofferdam was considered to be so monumental and the stresses which a high flood level flow of 200,000 cubic feet per second would impose on it so great that the Government assumed responsibility for the integrity of the structure. The contractor's liability was limited to adherence to specifications prescribed by the Bureau of Reclamation. In accordance with those specifications, the main mass of the cofferdam is made up of an earth-gravel fill composed of 568,000 cubic yards, with a rock blanket of dumped riprap 3ft. thick on each slope. All told, 157,000 cubic yards of rock were used for the blanket, and silt and clay were sluiced into the voids to consolidate it. The upstream face is on a 3 : 1 gradient and the downstream slope is 4 : 1. The earth fill was compacted with 6-ton Rohl rollers, each drawn by a 30 horse-power tractor, and the earth, after being dumped from motor trucks, was spread by bulldozers attached to 30 horse-power caterpillar tractors. The earth was obtained from pits about 3 miles upstream, near the mouth of Hemenway Wash. At the pits electric shovels equipped with 3½ cubic yard dippers dug the material and loaded it into 30-yard side-dump cars that were hauled on the railway running along the Nevada side of the canyon above the high-water level. This railway was built by the contractor and required the driving of tunnels and the excavating of solid rock for a distance of fully 2 miles. When the earth from the pits reached the lower end of the railway it was dumped from a trestle and reloaded into motor trucks by 3½ cubic yard shovels and then hauled to points on the cofferdam site. During some twenty-four-hour periods as much as 18,000 cubic yards or 4000 truckloads of earth were placed in the cofferdam. As soon as the horizontal layers of earth were approximately a foot in thickness each of them was uniformly moistened and compacted by rolling. The earth contained an admixture of gravel, but no stones of a greater dimension than 9in. were permitted in this material. Thirty-five trucks were employed on this work. The shovels lifted and dumped a dipperful every thirty seconds, almost continuously day and night, operations after nightfall being made possible by an extensive arrangement of electric lamps.

The upstream toe of the cofferdam is protected by a cut-off consisting of a line of steel sheet piling driven into the river bed down to rock and extending from wall to wall of the canyon. The piles are of the arch web type and are 16in. wide, from 40ft. to 55ft. in length, and have a continuous interlock rolled in them from end to end. For the most part they were driven by means of a large McKiernan-Terry pneumatic hammer, but for a space near the Nevada wall numerous big boulders prevented driving. Throughout this stretch a trench was excavated and the piles were set on a concrete footing resting on basic rock. A 5 cubic yard drag-line fitted with an 80ft. boom was used to put the piles in their prescribed positions and then to hold the air hammer while the driving was being performed.

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* It seems desirable to continue to refer to the dam by its original title, in spite of the fact that it has been changed by officials of the new administration, which came into power with Mr. Roosevelt, to Boulder Dam. The dam is being constructed in Black Canyon. Boulder Canyon was considered as a site for it, but was abandoned in favour of the adjacent Black Canyon.

On each flank of the cofferdam anchored in vertical channels cut 3ft. deep in the rock are three concrete cut-offs 98ft. high which reach from bed rock to the crest of the cofferdam. These cut-offs are spaced 25ft. apart centre to centre. They are 8ft. across on their outer faces and project into the fill of the dam to a depth of about 5ft. The cut-offs are designed to obstruct seepage working its way downstream between the canyon walls and the body of the cofferdam and were poured in successive lifts as the earth fill mounted. The concrete required was hauled from the mixing plant in 4 cubic yard agitators and the agitators were lifted from the trucks and swung to the pouring sites by the large drag-line.

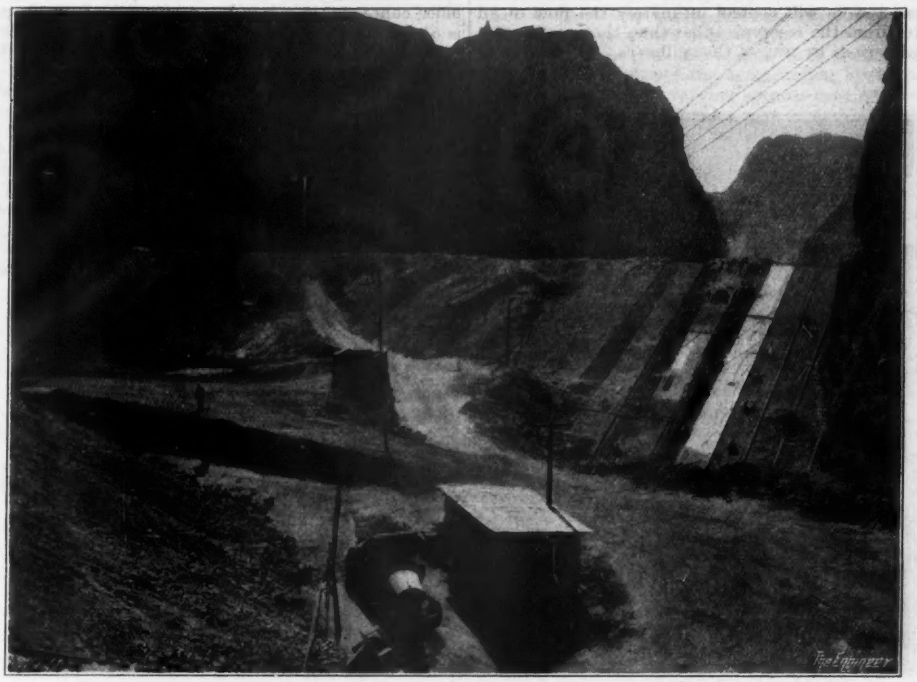

Fig. 2—Concreting the Upstream Face of the Upper Cofferdam

The rock for the 3ft. blankets on the front and rear slopes of the upstream cofferdam was obtained from the material produced in scaling the canyon walls and in excavating those walls for some of the external structural features of the project. The blankets were not placed on the slopes until the earth fill was nearly completed. While the building up of the cofferdam was still in progress, work was started on the 6in. reinforced concrete paving that covers the entire front face of the upstream cofferdam—see Fig. 2. According to the specifications: "The concrete paving shall be laid in strips not over 16ft. in width running up and down the slope of the cofferdam, and construction joints, across which the reinforcement bars shall be continuous, shall be provided between the strips." These 16ft. sections rise from a concrete curb at the sheet-piling cut-off and extend to the crest of the dam. The concrete used was trucked to the crest of the cofferdam and then delivered to the placing points through timber chutes. The pavement is composed of 3500 cubic yards of concrete and 251,000 lb. of ⅝in. reinforcing steel bars. In addition to the reinforced concrete pavement and the three concrete cut-offs in each canyon wall, seepage is further guarded against by a rubber fabric seal at each side of the canyon, and by a rubber seal at the lower edge of the pavement. The connection between the pavement and the cut-off piling includes a sheet rubber water stop and a backfilling of puddle clay under a 5ft. thickness of dumped rock. Where the paving abuts against the canyon walls, there is interposed a continuous sheet rubber water stop made up of tire fabric ¼in. thick and 36in. in width. This fabric is folded down into the space between the edge of the pavement and a curb of concrete set in each wall on a ledge cut for the purpose, the fabric being fastened to the curb and to the pavement. This flexible water stop will accommodate any settlement of the cofferdam as a whole, or any movement in the pavement.

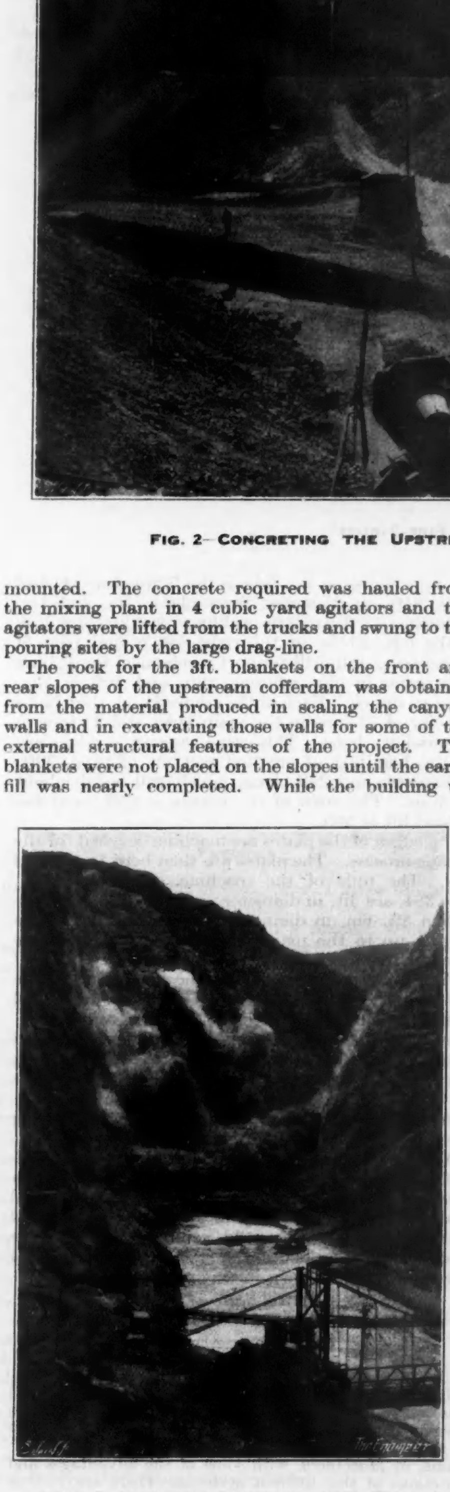

Fig. 3—Blasting Rock at Dam Site

In its finished state, the upper cofferdam is 480ft. long between the walls of the canyon, has a maximum height of 98ft., is 70ft. wide at the crest, and has a basal spread in cross section of 750ft. The crest of the dam is 13ft. above the assumed level of a maximum flood of 200,000 cubic feet per second. Before the construction of the upper cofferdam could be started it was necessary to excavate about 213,000 cubic yards of stream-bed deposit consisting for the most part of sand and gravel. Most of this material was transported upstream and dumped at the mouth of Hemenway Wash. The excavation for the upper cofferdam was started on September 25th and finished on December 5th, 1932. The earth fill was started on October 31st, 1932, and was completed on January 1st, 1933. The reinforced concrete pavement was placed between December 20th, 1932, and the end of February, 1933. The work was rushed in order to take advantage of the low-water period of the Colorado.

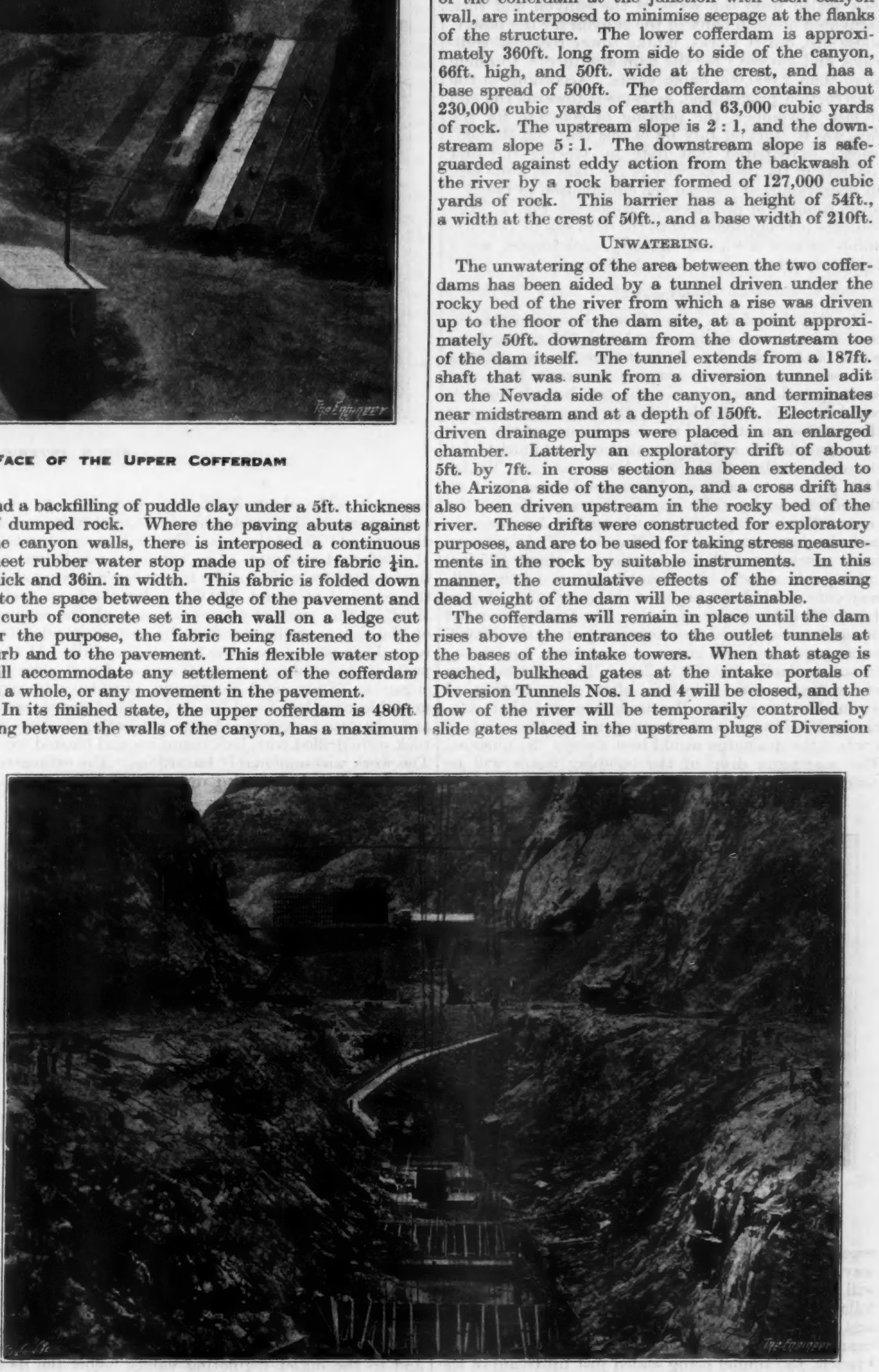

Fig. 4—Pouring Concrete for the Dam—June 6th, 1933

The Lower Cofferdam.

The construction of the lower cofferdam was delayed by scaling operations on the canyon walls and by excavations at the sites of certain of the outlet works, and also on the canyon walls. The earth-gravel fill for this cofferdam was also obtained from Hemenway Wash. The construction railway was extended downstream to a trestle near the dam site, where the material was dumped and then hauled by motor trucks to the cofferdam site. This cofferdam is protected on its upstream face by a 3ft. blanket of rock. The downstream face has no protective surfacing, nor has either slope a concrete pavement. Two concrete cut-offs, reaching from the base to the crest of the cofferdam at the junction with each canyon wall, are interposed to minimise seepage at the flanks of the structure. The lower cofferdam is approximately 360ft. long from side to side of the canyon, 66ft. high, and 50ft. wide at the crest, and has a base spread of 500ft. The cofferdam contains about 230,000 cubic yards of earth and 63,000 cubic yards of rock. The upstream slope is 2 : 1, and the downstream slope 5 : 1. The downstream slope is safeguarded against eddy action from the backwash of the river by a rock barrier formed of 127,000 cubic yards of rock. This barrier has a height of 54ft., a width at the crest of 50ft., and a base width of 210ft.

Unwatering.

The unwatering of the area between the two cofferdams has been aided by a tunnel driven under the rocky bed of the river from which a rise was driven up to the floor of the dam site, at a point approximately 50ft. downstream from the downstream toe of the dam itself. The tunnel extends from a 187ft. shaft that was sunk from a diversion tunnel adit on the Nevada side of the canyon, and terminates near midstream and at a depth of 150ft. Electrically driven drainage pumps were placed in an enlarged chamber. Latterly an exploratory drift of about 5ft. by 7ft. in cross section has been extended to the Arizona side of the canyon, and a cross drift has also been driven upstream in the rocky bed of the river. These drifts were constructed for exploratory purposes, and are to be used for taking stress measurements in the rock by suitable instruments. In this manner, the cumulative effects of the increasing dead weight of the dam will be ascertainable.

The cofferdams will remain in place until the dam rises above the entrances to the outlet tunnels at the bases of the intake towers. When that stage is reached, bulkhead gates at the intake portals of Diversion Tunnels Nos. 1 and 4 will be closed, and the flow of the river will be temporarily controlled by slide gates placed in the upstream plugs of Diversion Tunnels Nos. 2 and 3. The upper cofferdam will then be overtopped by the water in the reservoir impounded by the dam. The lower cofferdam and its rock barrier are then to be removed to clear the river channel and the tail-race for the efficient operation of the power plant.

Foundations.

Between the two cofferdams, starting at the downstream toe of the main cofferdam, the contractor was called upon to expose the rocky bed of the river for an average width of 450ft. and for a distance of 1200ft. to ascertain the exact condition of the rock preparatory to excavating the area to be occupied by the foundation of the dam. The work of making the dam site alone ready for the pouring of concrete involved the drilling, blasting, and removal of more than 100,000 cubic yards of rock—see Fig. 3. All excavated material was transported by motor trucks from the unwatered area, up a broad roadway on the downstream slope of the upper cofferdam, and dumped at loading docks a few hundred yards away. From that point the material was moved to Hemenway Wash by trains or used to widen the railway embankment on the Nevada side of the river. Many of the trucks were fitted with duralumin bodies and were capable of hauling unit loads of 16 cubic yards. The trucks moved in a continuous procession, night and day, and at times as many as 7000 truckloads were disposed of in the course of twenty-four hours.

It should be borne in mind that the quantity of rock to be removed within the unwatered area included rock scaled from the walls of the canyon and rock excavated on each flank of the canyon for the powerhouse site, outlet works, intake tower recesses, spillways, and keyways for the dam abutments, totalling more than 2,000,000 cubic yards. According to the construction programme, as revised towards the end of last November, the pouring of concrete for the dam was to start on July 1st of this year, but the contractor anticipated that date by placing the first concrete in the deep keyway of the dam on June 6th, an operation that marked the culmination of twenty-seven months of preparatory work—see Fig. 4. The concrete is being delivered to the dam site by bottom-dump buckets of 8 yards capacity, each bucket, when loaded, weighing approximately 20 tons.

SPILLWAYS.

By May 1st of this year all four diversion tunnels were finished and ready to deal with the spring flood water of the Colorado. At that time the two Arizona diversion tunnels were carrying the whole flow, and on forty-eight hours' notice the two Nevada tunnels could be made available. By the same date most of the penstock tunnels on the Nevada side of the river were completed, and the excavation was finished for six of the outlets to the valve house, and the 7ft. by 14ft. pioneer tunnel from Diversion Tunnel No. 2 to the intake tower—also on the Nevada side of the river. The corresponding work on the Arizona side had also been excavated by May 1st. The spillways have necessitated the excavation of about 625,000 cubic yards of rock. As originally planned,[†] the spillway cuts would have required the excavation of over 1,000,000 cubic yards of rock. The finally accepted design has thus saved the excavating of nearly 400,000 cubic yards and will result in economies amounting to substantially 500,000 dollars. The adopted form of spillway was selected after the testing of a number of types. Research disclosed that side-channel spillways with drum gates at the crest to control the discharge would best answer the purpose. The maximum drop of the escaping water will be nearly 530ft., and in that descent the water would reach a velocity of 175ft. per second. In each spillway, as now under construction, the released water will flow over a 26ft. weir, make a 90 deg. turn, then follow a descending channel parallel with the weir, and finally enter an inclined shaft 600ft. long that connects at the bottom with one of the 50ft. diversion tunnels, the tunnel being sealed just upstream of the junction by a concrete plug. Each spillway cut is 650ft. long and each spillway is to be equipped with four drum gates, 100ft. long and 16ft. in diameter. The spillway cuts are to be lined with 24in. of reinforced concrete. The spillway floors slope toward their discharge shafts on a gradient of 1 in 10.

The inclined tunnels connecting with the spillways were driven from their respective diversion tunnels by top-centre headings 7ft. high and 14ft. wide. The succeeding enlargement operation will be postponed in the case of the Arizona tunnel until Diversion Tunnel No. 3—now carrying water—becomes available for the conclusion of the work. The inclined spillway tunnel on the Nevada side was deepened by successive benching, the rock removed during the enlargement being disposed of by dropping it down into the diversion tunnel, from which it was removed.

INTAKE TOWERS.

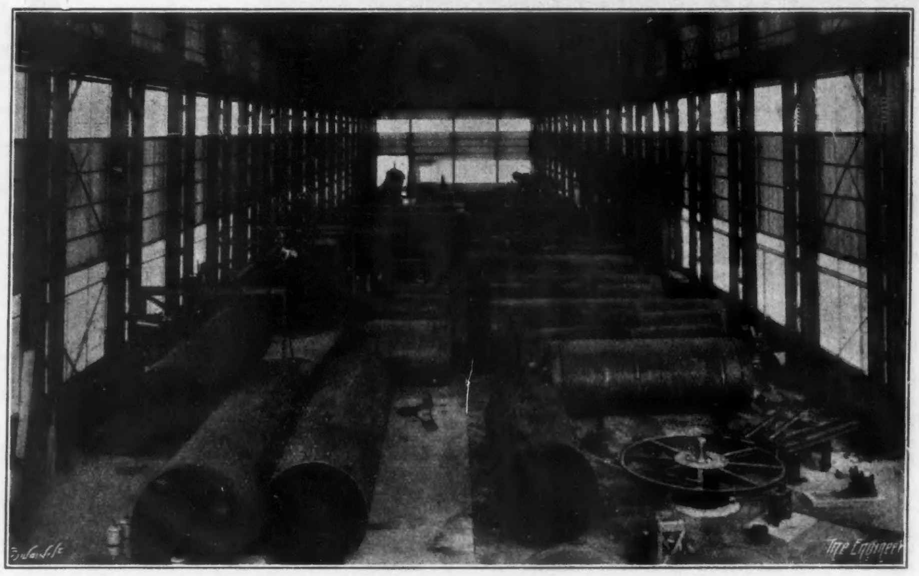

FIG. 6—INTERIOR OF PIPE-HOUSE

Two spectacular phases of rock work have been those associated with the scaling of the canyon walls and with the excavation of the shelves and the deep recesses that are to receive the four intake towers. These towers will control ultimately the flow of all water from the reservoir other than that escaping at flood periods by way of the spillways. Each of these towers is to be about 390ft. high from base to top, with an external diameter at the base of 82ft. and a diameter of 67ft. at the top. They will be constructed of reinforced concrete. The recesses and shelves in the two canyon walls for the towers have necessitated the removal of about 320,000 cubic yards of rock. Much of this work of excavation and all the scaling on the canyon walls was done by men suspended by rope slings passed over the tops of the cliffs. At the peak of these activities many scores of men were so engaged. They used duralumin pinchbars to pry unstable rock loose and air jets to blow away small and shattered masses. Large projecting bodies of rock were drilled with jack hammers and blasted free. The work was undeniably hazardous. The estimated amount of rock removed during scaling operations has been put at 150,000 cubic yards. Scaling is now finished.

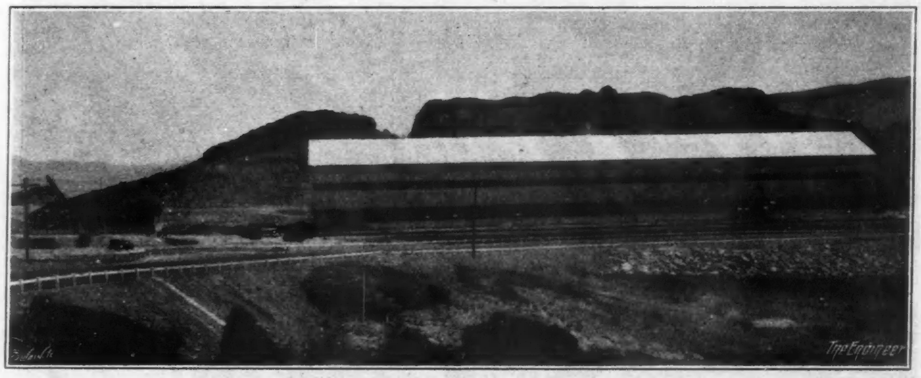

FIG. 5—PIPE FABRICATING HOUSE ADJACENT TO BLACK CANYON

FABRICATION OF STEEL CONDUITS.

From each of the four intake towers a steel pipe, 30ft. in diameter, will convey water for the turbines and to the outlet regulating valves below the dam. From each of the 30ft. pipes four 13ft. diameter penstocks—that is, sixteen in all—will feed the turbines, one penstock being branched at its end to serve two turbines. The 30ft. pipes, which vary between 1030ft. and 1280ft. in length, will be extended by 25ft. pipes to the four outlet stations, which will be served by groups of pipes, 8ft. 6in. in diameter.

The contract for these steel pipes was given to the Babcock and Wilcox Company, of New York, and since the conveyance of such large parts over long distances was out of the question, a special plant for their manufacture was erected on the rocky slopes above the Canyon. The pipes, as completed, are being handled by the cableway to be described later. A general view of the pipe-house is reproduced in Fig. 5 and other views are given on page 384.

This plant is fully equipped to fabricate by fusion welding, and to test by X-ray, 14,500ft. of pipe, 8½ft. to 30ft. in diameter, from steel plate ranging in thickness from ⅞in. to 2¾in. Approximately 400,000 linear feet of welding will be performed in the fabrication of these pipes. The shop building is 520ft. long by 90ft. wide, and is 56ft. high from the floor to the bottom chord of the roof trusses. The total floor space, including that of a laboratory and foreman's office contained in a lean-to on one side of the shop, is 51,500 square feet.

In the interior view of the plant (Fig. 6) the work seen in progress on the floor is the fabrication of steel pipes, 8½ft. in diameter, from plates ⅞in. and 1in. in thickness. Automatic welding machines are seen on the left, whilst in the right foreground part of the indexing and drill-support mechanism for drilling girth seams in pipe sections, 25ft. and 30ft. in diameter, is shown. Each of the cranes in the shop has a capacity of 75 tons in the main hoist and 25 tons in the auxiliary hoist. This crane capacity is necessary for the handling of erection sections of pipe, 30ft. in diameter and 24ft. long, which will weigh about 150 tons. The span of the cranes is 85ft., and the vertical lift is 50ft.

The edges of the plates are machine bevelled for the welding process. The plates are then bent in vertical rolls. The rolls of the machine, shown in Fig. 7, page 384, are 3ft. in diameter and 12ft. high. A pipe section 8ft. 6in. in diameter is being rolled. Plates ranging up to the maximum thickness of 2¾in. are rolled in this machine.

Fig. 8 on page 384 shows the machining of the end of an 8½ft. pipe section. A large horizontal boring machine is to be seen in the background.

In Fig. 9 the mounting of two pipes 8½ft. in diameter on rolls under an automatic fusion welding machine, preparatory to welding a girth seam, is shown. The spider for holding the seam in alignment and constituting a backing member for welding is seen within the section.

A section of an 8½ft. pipe, mounted under an automatic fusion welding machine, for the welding of the longitudinal seam, is shown in Fig. 10. The general quality of each weld is indicated by the physical characteristics of the weld joining the end-piece specimens tack-welded to the pipe sections at one end of each seam, as shown in this photograph.

(To be continued.)

[†] Compare Fig. 1 herewith with Fig. 5, page 582, of our issue of December 9th, 1932.

Now that thread grinding is beginning to be considered as an essential process in good engineering work, it becomes necessary for those responsible for the selection of plant for this purpose to acquaint themselves, says Mr. H. F. Atkins, in *Machinery*, with some of the advantages and limitations of the different systems. There are various multi-ribbed wheel machines and machines designed for using single-ribbed wheels. While the single-ribbed wheel cannot remove as much metal in a given time as a multi-ribbed wheel, it is much more quickly dressed and re-dressed; it is changed from one pitch to another without removal and consequent risk of damage; the shape of the thread is more easily controlled; the pitch is more regular and correct, as there are less conflicting elements; there is less heat produced with its detrimental effect on pitch and truth; and it is adaptable to threads such as the Acme that cannot be ground with multi-ribbed wheels. Further, the correct form of Whitworth thread is better maintained. For a variety of work the single-rib wheel is preferable to a multi-rib type, and if the output warrants it, may be used in conjunction with machines of lower capital cost which rough out the thread.

Heat Transfer in Electric Furnaces.

By E. G. FIEGEHEN, M.I. Mech. E.

It is proposed in the present article to investigate the approximate distribution of heat in electric resistor type furnaces, used for the annealing and heat treatment of steel castings. Such furnaces are generally run at about 1750 deg. Fah., the maximum temperature desired in the castings being about 1650 deg. Fah.

We will take as an example a car type annealing furnace, having a hearth 20ft. long by 9ft. wide, and handling side-frame castings for box cars weighing from 500 lb. to 600 lb. each and requiring, according to their metal thickness, an annealing period of about 60 minutes, followed by a soaking period of 30–45 minutes.

The wall construction consists of 9in. of fire-brick, backed by 5in. of insulation and encased in a plated shell. It will be assumed for simplicity that the same brick construction is used for the furnace roof, car platform and end doors, of which there are two, to facilitate the transfer of cars. Fig. 1 gives the principal dimensions of this furnace.

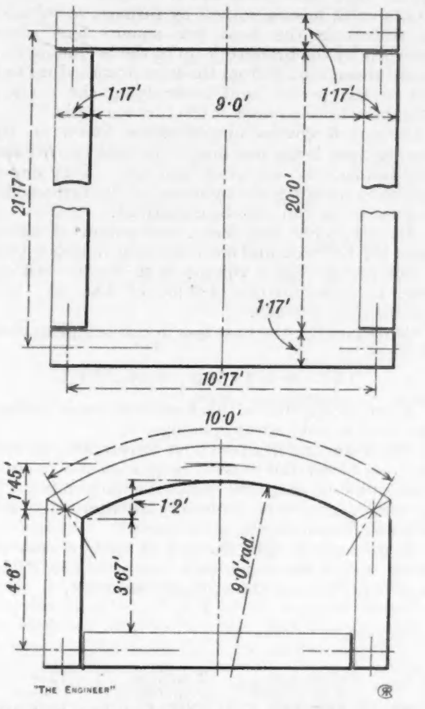

FIG. 1—DIMENSIONS OF ELECTRIC ANNEALING FURNACE

The normal loading of such a furnace would be about 60 lb. per square foot of hearth area per hour; in this case

$$60 \times 9 \times 20 = 10{,}800, \text{ say, } 11{,}000 \text{ lb.}$$

Upon completion of the annealing period the heated car with its load is pulled out at one end of the furnace, whilst a loaded car of cold castings is pulled in at the other end, the cars being coupled together for the purpose. During this operation current is turned off and the temperature of the surface of the furnace walls falls appreciably, which happens to be an advantage. Castings of appreciable thickness of metal are liable to crack if introduced into a fully heated furnace, causing a heat gradient in the thickness of the metal in excess of the safe limit, which is approximately 20 deg. to 25 deg. Fah. temperature difference per inch of penetration for soft steel, and the heat input has to be regulated to keep the rate of temperature rise within this limit.

In the present case, however, the thicknesses of the castings range around ¾in., and no risk is incurred in this respect. The introduction of the cold castings causes the surface temperature of the furnace walls to drop still lower, and by the time that the doors have been closed and sealed by sand, the current may be turned on, for, owing to the presence of the cold castings, the resistors will take several minutes to reach normal working temperature.

Furnace Walls.

We will now turn our attention to the transfer of heat to the furnace walls.

In the early stages of heating we shall find that these absorb heat at a rate which is extremely great compared to the average rate of transfer over an extended period.

The study of heat transfer in refractories by mathematical means is exceedingly difficult and tedious, even when the variation of the coefficients of specific heat and conductivity with temperature are ignored. Fortunately, a graphical method[*] of finding the relation of temperature, space, and time has been devised, whereby the temperature variation in a conductor, such as a furnace wall, with regard to time can be investigated quite simply, and with sufficient accuracy for all commercial purposes.

Fig. 2 illustrates the application of this graphic construction to the case in hand.

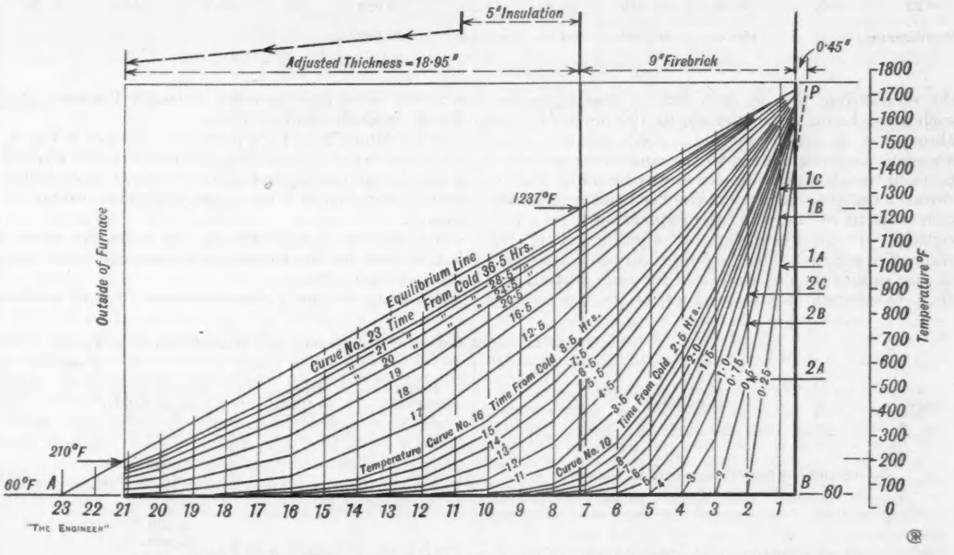

FIG. 2—GRAPHICAL METHOD OF STUDYING HEAT TRANSFER IN A FURNACE

For the purpose of this article, it is thought inadvisable to complicate the construction by adjustments to take care of varying specific heat and conductivity of fire-brick, but we may remark that this can be done quite simply when the result justifies the additional work.

Referring to Fig. 2 it will be noted that whilst the fire-brick thickness is drawn correctly to scale, that of the insulation is shown to a scale nearly four times as great The reason for this lies in the fact that the conductivity of the insulation is only about one-fourth that of fire-brick per unit of thickness, or, in other words, its resistance to heat transfer is four times as great as that of fire-brick. If, therefore, we draw the insulation approximately four times its actual thickness, we may consider it replaced, for the purposes of the diagram, by fire-brick of equivalent heat resistance, and the whole of the wall can be treated as if it were composed entirely of fire-brick.

The exact equivalent thickness is found as under:—

Let T_b be the temperature of the wall at the junction of the fire-brick and the insulation, when the furnace face of the fire-brick is at a temperature of, say, 1700 deg. Fah. From test results of walls of this construction, under such conditions, we find that the outer face of the insulation will, at equilibrium, attain a temperature of 210 deg. Fah. Then, using the usual formula:—

$$\frac{1700-T_b}{T_b-210}=\frac{9\text{in. (thickness of fire-brick)}}{5\text{in. (thickness of insulation)}}\times\frac{1\text{ (relative conductivity of insulation)}}{4\text{ (relative conductivity of fire-brick)}}$$

whence $T_b=1237$ deg. Fah.

This is a point on the equilibrium line of heat transfer in the wall, when fully heated. The upper end of this line cuts the 1750 deg. Fah. temperature level at a point whose distance from the inner face of the furnace wall and to the right of this is found by the formula relating to this construction

$$P_d=\frac{C}{K_2}=\frac{0\cdot75}{20}=0\cdot375\text{ft.}=0\cdot45\text{in.}$$

where

C = conductivity of fire-brick (B.Th.U. per square foot per hour per deg. Fah. per foot thickness),

K_2 = coefficient of heat transfer to face of fire-brick (B.Th.U. per square foot per deg. Fah. per hour).

Now join this "pole point" P with the equilibrium point (1237 deg. Fah.) already found and produce to cut the base line at 60 deg. Fah. Intersect the lower end of this line by a horizontal, drawn from the temperature scale at 210 deg. Fah. This is the lower equilibrium point for the wall.

At the intersection draw a vertical, which will represent the outer face of the insulation and indicate its corrected thickness.

Divide the base line A–B into $n+\frac{1}{2}$ spaces and erect ordinates commencing half a space from the point B and proceeding to the left ending at A.

Obviously the smaller the subdivisions the greater the accuracy obtainable, as will be seen later. The present base line has been divided into 22½ parts to obtain a clear diagram.

We have now to construct time-temperature curves, each of which will represent, graphically, the temperature distribution in the wall at the end of a definite time interval from a start from cold.

We will assume (what is practically true in this application) that the furnace face of the wall is exposed, continuously, to the full furnace temperature of 1750 deg. Fah.

Number the ordinates 1–23 from the right. Join pole point P with the base of No. 2 ordinate; this is our first temperature distribution curve.

To find the time interval $d\,t$ from cold that it represents, we use the formula:—

$$d\,t=\frac{(d\,s)^2\times q\times w}{2\times C}\cdot\text{hours}$$

wherein

$d\,s$ = spacing of ordinates (in this case 1·365in. = 0·1137ft.)

q = specific density of fire-brick (125 lb. per square foot),

w = mean specific heat of fire-brick (0·235),

C = conductivity of fire-brick, 1ft. thick (0·75).

We have then

$$d\,t=\frac{(0\cdot1137)^2\times125\times0\cdot235}{2\times0\cdot75}$$

$$=0\cdot253\text{ hour—say, }\tfrac{1}{4}\text{ hour.}$$

Each successive curve, constructed on the ordinate spacing adopted, will represent an additional lapse of ¼ hour from cold; for instance, curve No. 5 represents conditions 1¼ hour from cold start.

Proceeding, the second curve starts at the foot of ordinate 3 by a line drawn upwards in the direction of point 1*a*, until it meets ordinate 2; thence it is continued to meet pole point P.

Curve No. 3 (¾ hour from cold) starts at the foot of ordinate 4 and is drawn, in the direction of intersection 2*a*, until it meets ordinate 3; thence, in the direction of intersection 1*b*, until it meets ordinate 2, and thence straight to pole point P.

Thus each successive curve, starting from the base of the appropriate ordinate, is drawn upwards, in the direction of the intersection of the previous curve with the second ordinate to the right of the starting point, until it reaches the adjacent ordinate to the right, when it changes direction to point to the intersection of the previous curve with the second ordinate now on its right, stopping again at its adjacent ordinate on the right and again changing direction as before.

The last chord of a curve always connects the point where it intersects ordinate 1 and the pole point P.

A study of the diagram will indicate the method clearly.

The geometry on which this construction is based and the formulæ used are very simple indeed, and for these the reader is referred to Professor Trinks' excellent book.

The curves continuously fall closer to one another and, to avoid crowding on the diagram, the same construction may proceed using two-ordinate intervals ($2\,d\,s$).

It is evident from the formula (involving $(d\,s)^2$) that the time interval will be thereby quadrupled. When the curves crowd once more, the spacing or ordinates may again be doubled ($4\,d\,s$) and the time interval will once more be quadrupled.

In the figure, curves 1–10 will be seen to be constructed at ordinate intervals, curves 11–16 are at double ordinate intervals, and the upper group are at four ordinate intervals. The change in construction can be plainly seen, the chords of the curves doubling in length with each change.

On each curve is marked the time interval, from cold, that it represents.

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[*] Trinks, "Industrial Furnaces," Part I.

Obviously the real distribution would follow smooth curves, but the polygonal lines, given by this construction, serve the purpose sufficiently well, considering the possible variation of many of the factors in the problem.

The "equilibrium line" represents temperature conditions after a steady state of heat transfer in the wall is finally reached if the heating continues for several days.

Heat Absorption.

To study the heat absorption of the fire-brick and insulation, in relation to elapsed time, the area under the equilibrium line in each section was measured, such areas being proportionate to 100 per cent. heat absorption in each section. The relative heat absorption corresponding to the conditions indicated by each time temperature curve was found by finding the area under each curve in the fire-brick and insulation sections of the wall, and expressing it as a percentage of the absorption at equilibrium in the respective section. The "equilibrium heat capacity" of one square foot of wall area for each section was then calculated as the product of its weight (per square foot of wall), its mean specific heat and the mean temperature rise from 60 deg. Fah.; the result is shown in columns 4 and 6 of Table I. opposite the reference "equilibrium."

Table I.—*Progressive Absorption of Heat by 1 Square Foot of Vertical Wall.*

		Fire-brick.		Insulation.		Wall.	Surface loss.			Totals.
Time-temperature curve, No.	Elapsed time from cold, hours.	Per cent. of equilibrium B.Th.U.	Total B.Th.U. absorbed from cold.	Per cent. of equilibrium B.Th.U.	Total B.Th.U. absorbed from cold.	Total B.Th.U. absorbed. by 1 sq. ft. from cold.	Temperature, surface of wall.	Emission B.Th.U. per sq. ft. per hour.	Emission in B.Th.U. per sq. ft. from cold.	Total B.Th.U. to 1 sq. ft. of wall from cold.
1	¼	15·1	4,910	—	—	4,910				4,910
2	½	23·2	7,540	—	—	7,540				7,540
3	¾	29·9	9,720	—	—	9,720				9,720
4	1	35·2	11,420	—	—	11,420				11,420
5	1¼	40·5	13,150	—	—	13,150				13,150
6	1½	45·0	14,600	—	—	14,600				14,600
7	1¾	45·9	14,900	—	—	14,900				14,900
8	2	46·8	15,200	—	—	15,200				15,200
9	2¼	49·8	16,180	—	—	16,180				16,180
10	2½	52·3	16,980	1·85	26	17,006				17,006
11	3½	60·5	19,650	3·80	53	19,703				19,703
12	4½	66·2	21,500	7·37	102	21,602				21,602
13	5½	70·5	22,870	13·70	189	23,059				23,059
14	6½	74·1	24,060	17·63	243	24,303				24,303
15	7½	77·3	25,120	21·26	294	25,414				25,414
16	8½	80·3	26,100	27·35	378	26,478				26,478
17	12½	86·6	28,130	41·30	570	28,700	75	36·8	147	28,847
18	16½	90·3	29,360	52·80	730	30,090	93	88·0	499	30,589
19	20½	93·0	30,250	65·70	908	31,158	115	92·6	869	32,027
21	24½	94·7	30,750	74·40	1,027	31,777	136	138·0	1,421	33,198
21	28½	96·1	31,200	80·20	1,108	32,308	155	181·2	2,145	34,453
22	32½	97·0	31,510	85·80	1,185	32,695	170	220·0	3,025	35,720
23	36½	97·8	31,850	89·20	1,230	33,080	180	245·5	4,007	37,087
Equilibrium	—	100·0	32,500	100·0	1,380	33,880				

The heat absorption represented by the various curves was calculated by multiplying this figure by the appropriate percentage of area under the curve, related to that under the equilibrium line in each section and appears in the same columns of Table I; totals of these figures appearing in column 7 of the table, give the heat absorption for the entire wall at the successive stages.

In Fig. 2 it will be noted that not until we reach curve No. 17 (12·5 hours from start) does heat actually reach the outer face of the insulation. Up to that point the flow of heat has been entirely absorbed by the material of the wall. The succeeding curves emerge at increasing heights, indicating corresponding outside wall temperature. From these the heat emission by radiation and convection from the hot surface per square foot of wall has been calculated, and is shown in column 10. Column 11 is the total of figures in columns 7 and 10, and thus represents the total heat transfer, through 1 square foot of wall, from the source of heat.

These values have been plotted as a curve in Fig. 3, which was drawn as a fair approximation to the plotted points; closer correspondence is hardly to be expected when the "curves" used are polygonal instead of smooth.

We are now in a position to estimate the absorption of heat by the furnace after any specified time interval from cold.

Referring to Fig. 1 measurements of wall surface area will be taken on the median lines in the wall thickness, as indicated.

Thus we have :—

Floor area = 10·17 × 21·17	= 215	sq. feet
Roof area = 10·0 × 21·17	= 212	„
Two side walls = 2 × 21·17 × 4·6.. ..	= 200	„
Two doors = { 2 × 4·6 × 10·17 ..	= 93	„
+ 2 × ⅔ × 1·45 × 10·17	= 20	„
	740	„

We could use the method of Fig. 2 with appropriate constants to investigate the rate at which the 11,000 lb. of steel castings will receive heat during the annealing period of 60 minutes. This, however, would not be of great interest, owing to the moderate thickness in this case.

The total heat required to raise the charge of castings to the annealing temperature of 1650 deg. Fah. is

11,000×250 (B.Th.U. in 1 lb. of steel raised from 60 deg. to 1650 deg. Fah.)=2,750,000 B.Th.U.

Electricity Consumption.

We now come to the electrical aspect of the problem. We have

1 kilowatt-hour=3412 B.Th.U.

Since the steel absorbs 2,750,000 B.Th.U., in a heat of one hour duration, then the net kilowatt capacity required for this alone is

2,750,000/3412=806 kilowatts.

Table II. has been prepared to show the heat requirements of the furnace and the electrical input at various times from a cold start and for usual working conditions.

Column 4, heat required by steel charge, has already been calculated, and is constant.

Column 5, heat absorbed by furnace, is calculated by deducting the heat per square foot already absorbed by the brickwork up to the beginning of the period (from Fig. 3) from the heat absorbed up to the end of the period, and multiplying the result by 740, the estimated area of the furnace walls.

Column 6 covers miscellaneous losses of heat. Among these is the loss due to the heat carried out of the furnace by escaping hot air. This depends primarily upon the air-tightness of the furnace doors and seals, and can only be guessed at.

At, say, 1700 deg. Fah., one pound of air contains 457 B.Th.U., and one cubic foot weighs 0·018 lb.

The furnace has a volume of 40·2×20=804 cubic feet, or 804×0·018=14·7 lb. of hot air, whose specific heat is 0·269.

Consequently, the heat loss in one complete change of air is

14·7×0·269×1640=6500 B.Th.U.

There are no flues in this furnace to cause a draught and suck in cold air at openings.

When starting from cold, air convection will induce cold air below the middle height of the doors and expel it above that line, but as the temperature of the furnace begins to be uniformly distributed, this flow will be reduced to a small amount.

If we assume eight changes of air in a heat of 1½ hours, this corresponds to a loss of 52,000 B.Th.U., say, 12 per cent. of the average heat input.

Table II.—*Heat Requirement of Furnace and Electrical Input for Various Working Conditions.*

Case.	Conditions.	Hours from cold start.	Heat to steel, B.Th.U.	Heat to furnace (from chart), B.Th.U.	Miscellaneous losses, say, 12 per cent.	Radiation loss, one door open 10 min., B.Th.U.	Total heat required, B.Th.U.	Electrical input, kilowatts.
A.	Empty furnace heated from cold in 4 hours	1–4	—	21,000×740 =15,550,000	1,865,000	—	17,415,000	17,415,000 3412×4 =1278 kW
B.	First heat of 1½ hours	4–5½	2,750,000	23,200 21,000 2,200×740 =1,630,000	527,000	238,500	5,145,500	5,145,500 3412×1·5 =1005 kW
C.	Second heat of 1½ hours..	5½–7	2,750,000	25,000 23,200 1,800×740 =1,330,000	490,000	238,500	4,808,500	4,808,500 3412×1·5 =940 kW
D.	Third heat of 1½ hours	7–8½	2,750,000	26,300 25,000 1,300×740 =963,000	446,000	238,500	4,397,500	4,397,500 3412×1·5 =861 kW
E.	Fourth heat of 1½ hours..	8½–10	2,750,000	27,400 26,300 1,100×740 =814,000	428,000	238,500	4,230,500	4,230,500 3412×1·5 =851 kW
F.	Fifth heat of 1½ hours	10–11½	2,750,000	28,300 27,400 900×740 =666,000	409,000	238,500	4,063,500	4,063,500 3412×1·5 =794 kW
G.	Heating up empty furnace which has retained 30 per cent. of its heat over week-end	4 hours to heat up	—	0·60×21,000×740 =9,300,000	1,117,000	—	10,417,000	10,417,000 3412×4 =764 kW
H.	Alternative to "A" heat up empty furnace from cold in 6 hours	1–6	—	23,900×740 =17,650,000	2,120,000	—	19,770,000	19,770,000 3412×6 =969 kW

Column 7 contains an estimate of the heat loss when the end doors are open whilst changing cars.

In this process, one door is fully opened, for the passage of the heated car, the other door being fully opened for the entry of the cold car, which is coupled to the back end of the hot car. As soon as the cold car is in position, both doors are closed on their end seals. The doors are generally air-operated and the cars pulled by power, so that an interval of 5 minutes with both doors open, equivalent to 10 minutes' radiation from one door, should cover the heat loss from this source and minor incidental losses.

The radiation loss is expressed by the formula :—

$$\text{B.Th.U. per hour} = 0\cdot15 \times A \left[\left(\frac{T_f}{100}\right)^4 - \left(\frac{T_a}{100}\right)^4\right]$$

T_f and T_a being the absolute temperature deg. Fah. of the furnace and air respectively. A is the area of the opening in square feet. This works out to

$$\text{B.Th.U. for 10 minutes} = \tfrac{1}{6} \times 0\cdot15 \times 40\cdot2$$
$$[(22\cdot1)^4 - (5\cdot2)^4] = 238{,}500 \text{ B.Th.U.}$$

This amount of heat has, of course, to be restored to the walls during the progress of the next heat.

Now examining Table II., we observe that the heat requirements steadily fall as the day advances, this being due to the furnace walls approaching the state of heat equilibrium. This is very marked in Column 5.

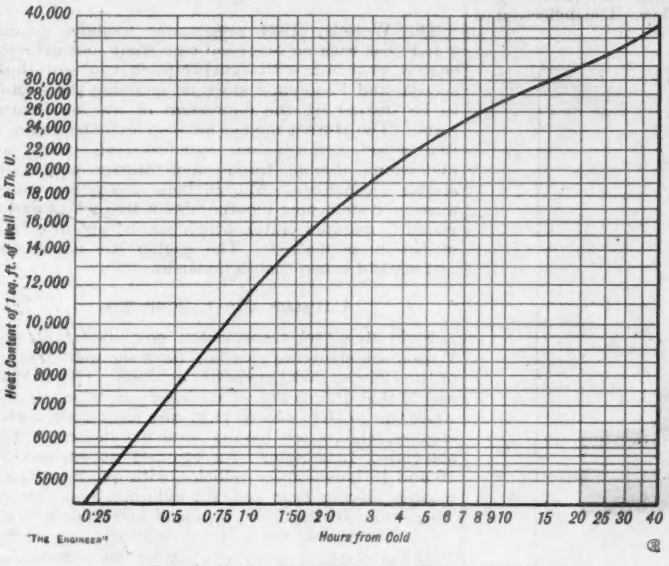

Fig. 3—Heat Absorbed by Brickwork

Now with regard to the electrical input required, it is undesirable to have this too great, having regard to cost of installation, demand factor, and efficiency of utilisation. On the other hand, the annealing process is doubtless part of a definite production cycle and the time per heat cannot be varied to a great extent. It would seem that in the present case a connection of about 950 kW would be most suitable. After week-end shutdowns, case H would be representative and case B could be extended to, say, 1 hour 40 minutes to reduce the demand to this figure. After a repair or a long shutdown, case A would apply, and it would be necessary to start earlier and extend the heat over about 5½ hours.

The estimated B.O.T. units (kilowatt-hours) in each case is as follows :—

Case A	5100	Case E..	1240
Case B	1520	Case F	1190
Case C..	1410	Case G..	2950
Case D	1280	Case H	5780

In connection with cases A, G, and H it may be asked: "When is a furnace to be considered as 'heated up'?" An American writer† has stated that a furnace may be considered as "heated up" for practical purposes when the temperature in the fire-brick at a depth of 2in. below the furnace face has attained a temperature which is 75 per cent. of the normal temperature of the furnace, this conclusion being reached after a series of practical tests. It will be seen from Fig. 2 that this corresponds with the present construction to curve No. 11 (3·5 hours from cold start).

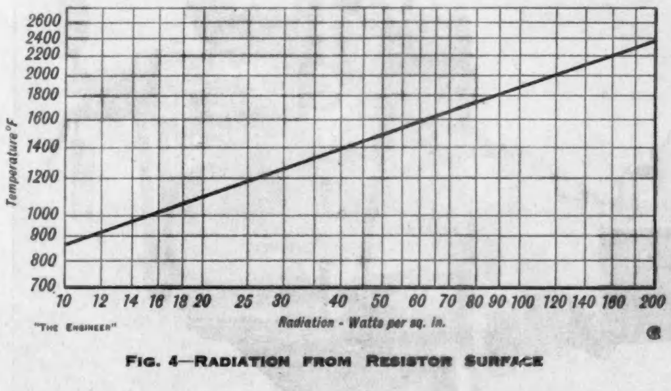

Fig. 4—Radiation from Resistor Surface

In fuel-fired furnaces a certain amount of overload capacity may be secured by burning more than the normal amount of fuel, perhaps at the expense of efficiency; but in the electric resistor type furnace the heat output is strictly limited by the constant voltage of the supply and the resistance of the resistors at furnace temperature.

In this connection one point should be noted that has a bearing upon the kilowatt capacity desirable. We have spoken of an "annealing period" and a "soaking period." In the case of thin castings the heat penetrates so fast relatively that these periods are indistinguishable, but take a thick casting; at the end of the "annealing period" the surface is supposed to be up to temperature and the pyrometer-controlled gear operates to reduce the heat input to that required to complete the penetration of heat to the centre of the casting thickness and some additional heat to the walls and to replace losses.

It is nearly as undesirable to have excessive kilowatt capacity connected to a furnace as to be underpowered, for it results in too frequent operation of the automatic heat control gear.

The interaction of radiation from the resistors and from the furnace is interesting. Fig. 4 shows watts radiation per square inch of resistor surface at various temperatures. Furnace resistors are generally rated to emit about 12 watts per square inch in normal working.

It will be seen from the chart that when exposed to room temperature only they attain this rate of emission at a resistor temperature of approximately 916 deg. Fah. Since the connected kilowatt capacity will not provide more than this normal demand of 12 watts per square inch, what happens when, in the furnace, they attain a temperature of 1750 deg. Fah. and by virtue of being at that temperature radiate at the rate of about 79·4 watts per square inch ?

The reason for this is that radiation is universal. All bodies hot and cold (down to the temperature of absolute zero −460 deg. Fah.) radiate heat in proportion to the fourth power of their absolute temperature. When two bodies are in range of each other the radiation is mutual. The resistor radiates to the furnace and its contents, according to its absolute temperature (as shown by Fig. 4) and at the same time the furnace radiates heat back to the resistor, according to the absolute temperature of the furnace. The resulting heat exchange corresponds to the difference in intensity of radiation.

The conditions are comparable with pressure and back pressure of fluids. In a pipe subject at one end to 80 lb. per square inch pressure and operating against 68 lb. per square inch back pressure the flow of fluid will correspond to an effective pressure of 12 lb. per square inch.

A resistor at 1750 deg. Fah., radiating, therefore, 79·4 watts per square inch, will be in heat equilibrium in a furnace which is radiating back to it heat energy at the rate of 67·4 watts per square inch, when supplied with the difference of 12 watts per square inch by its electricity supply. The furnace temperature corresponding to the above is 1658 deg. Fah.

The resistor cannot get any hotter than 1750 deg. Fah. under the above conditions, since it cannot draw further energy from the electricity supply to do so, but let the furnace cool to, say, 1483 deg. Fah., corresponding to a reduced radiation of 47·8 watts per square inch, then the resistor must correspondingly drop in temperature until it is radiating 12 watts per square inch in excess of this or 59·8 watts per square inch, corresponding to a temperature of 1580 deg. Fah. This automatic adjustment may be witnessed by bringing a cold mass of metal close to a heated resistor element (say, of a household appliance) which immediately loses its glow in the act of adjusting its emission to the amount of electric energy that it is receiving.

Conclusion.

Electric heating is becoming increasingly popular on account of its high efficiency, ease of control, cleanliness and the maintenance of a neutral atmosphere in the furnace, reducing scaling to a minimum. Furthermore, the maintenance of the refractories is much less, owing to the absence of flame and its scouring action.

In many localities, notably in Canada and America, off-peak power in large blocks for industrial purposes can be purchased at such low rates as to compete, at least on equal terms, with oil or coal firing, and such loads are welcomed by the power companies, since, being non-inductive, they have unity power factor and the heavy demand improves the load factor of the station.

The average oil-fired annealing furnace, without recuperation, has an overall efficiency of approximately 25 per cent. only, and of the total heat input about 50 per cent. escapes to the stack, for the gases must leave the furnace hotter than the charge. As a result of the low efficiency only 12–13 per cent. of the whole heat supplied goes to heat up the brickwork, and its rate of transfer becomes of minor importance. In the electric furnace there is no stack and the loss of heat in escaping gases is relatively small, consequently a much larger proportion of the heat input is absorbed by the brickwork, as can be seen by reference to Table II., and this matter becomes of sufficient importance to repay investigation.

It is hoped that a little light may have been shed on this matter in the present article.

The Quarter's Shipbuilding Returns.

The statistics issued by Lloyd's Register of Shipping regarding merchant vessels under construction at the end of September last show that in Great Britain and Ireland there is an increase of 16,260 tons in the work in hand as compared with the low figures for the previous quarter, and also that the present total—303,762 tons—is 65,329 tons greater than the tonnage which was being built at the end of September, 1932. An encouraging feature of the returns is the fact that, while at the end of September the tonnage on which work is suspended was identical with that at the end of June—about 134,000 tons of steamers and 6000 tons of motorships—the total of the tonnage now on the stocks maintains the upward trend which has been observable since the beginning of the year. About 57,000 tons—19 per cent. of the tonnage now being built in this country—is intended for registration abroad or for sale.

The tonnage now under construction abroad—452,990 tons—is about 8000 tons more than the work which was in hand at the end of June, 1933. This increment of the quarterly total of tonnage being built abroad is the first to be recorded since June, 1930. Tonnage, included in the total in hand abroad, on which work has been suspended amounts only to 1860 tons of steamers and 34,953 tons of motorships. The four leading countries abroad are :—France, 95,838 tons ; Japan, 85,570 tons ; Sweden, 71,440 tons ; and Holland, 40,862 tons. The total tonnage under construction in the world amounts to 756,752 tons, of which 40·1 per cent. is being built in Great Britain and Ireland, and 59·9 per cent. abroad. The total for the world at the end of September is higher than that at June 30th by 24,257 tons, which is the first quarterly increase in the world total to be noted for 3½ years.

In Great Britain and Ireland, 39,670 tons were commenced during the last three months. While this figure is 10,380 tons less than the corresponding total for the June quarter, with one exception it is larger than any quarterly total during the years 1931 and 1932. During the quarter ended September, 1933, 42,077 tons were launched in Great Britain and Ireland, showing an increase of 31,041 tons as compared with the June quarter. Similar figures for abroad are 71,102 tons commenced, and 90,233 tons launched, showing increases, as compared with the previous quarter, of 222 tons in the tonnage commenced, and 21,945 tons in the tonnage launched.

The oil tankers under construction in the world amount to 22 vessels of 149,064 tons, of which 5 vessels of 31,026 tons are being built in Great Britain and Ireland, 7 vessels of 47,600 tons in Sweden, 2 of 21,726 tons in Italy, 5 of 18,212 tons in Spain, and 1 of 12,400 tons in Germany. Of the 303,762 tons under construction in Great Britain and Ireland at the end of September, 87,294 tons consisted of motorships, while at the same date the motorship tonnage being constructed abroad—about 326,801 tons—was 202,947 tons in excess of that of the steamers. The vessels being built in the world at the end of September include 1 steamer and 11 motorships of between 8000 and 10,000 tons each ; 3 motorships of between 10,000 and 20,000 tons ; and 2 steamers and no motorships of 20,000 tons and upwards.

The table respecting marine engines shows that the horse-power of steam engines now being built or being fitted on board amounts to about 522,000 H.P.; these figures include 22 sets of turbine engines of about 423,000 shaft horse-power. The horse-power of the steam reciprocating engines—about 99,000 H.P.—amounts to 9·7 per cent. of the total horse-power of marine engines now being built in the world. The figures for oil engines aggregate approximately 494,000 H.P.

Although influenced by the reduced amount of shipbuilding in hand throughout the world, the total of the tonnage being built under the inspection of Lloyd's Register at the end of September amounts to 522,046 tons, viz., 275,362 tons under construction in Great Britain and Ireland, and 246,684 tons abroad.

* * *

Ahmedabad municipality proposes to have its own electricity undertaking, which has induced the Ahmedabad Electricity Company to offer the municipality the inducement of tariff reductions in order that the company's supply may continue. The company asks a guarantee of consumption ; on the other hand, it seems the municipality talks of calculations showing that the supply it has in mind will give much cheaper costs. There has been a conference between representatives of both sides, but so far we gather nothing definite has been decided.

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† M. H. Mawhinney, *Iron Age*, December 17th, 1931.

Motor Car Show at Olympia.

No. II.

(Concluded from page 352, October 13th.)

IT is obvious from a visit to Olympia that finality has by no means been reached in the design of spring suspension systems. The problem is apparently engaging more attention on the part of British car designers than hitherto. Both the Alvis and the Sunbeam companies have something new in this connection, although there are points of similarity common to both. In the new four-cylinder Sunbeam "Dawn" car a transverse front-leaf spring carries the entire weight of the front of the vehicle. As the spring is secured direct to the chassis frame at the centre the vertical movement of each front wheel is controlled by one half of the spring independently of the other half. Swivel brackets, equivalent to the ends of the usual axle, are further controlled by radius rods, which ensure that the angle of the wheel to the ground and the point of contact at various degrees of deflection of the spring are correct. The spring is relieved of the torsional effects of braking, &c., by the provision of long torque rods on either side of the chassis frame. All the joints in the complete mechanism have rubber silent-bloc bushes, which assist in damping the front springing and simplify maintenance, as they do not require lubrication. The four-cylinder engine—Fig. 3—rated at 12·8 horse-power, has cylinders 2·83in. bore by 3·93in. stroke. The engine has a combined cylinder block and crank case of aluminium, the cylinders being fitted with wear-resisting "wet" liners of chrome-nickel iron. Duralumin tappet rods are used to balance the expansion of the cylinder block. Pistons with aluminium alloy heads and steel skirt are fitted, and the mounting of the complete power unit is on rubber cushioning. The car is fitted with the Wilson pre-selective gear-box.

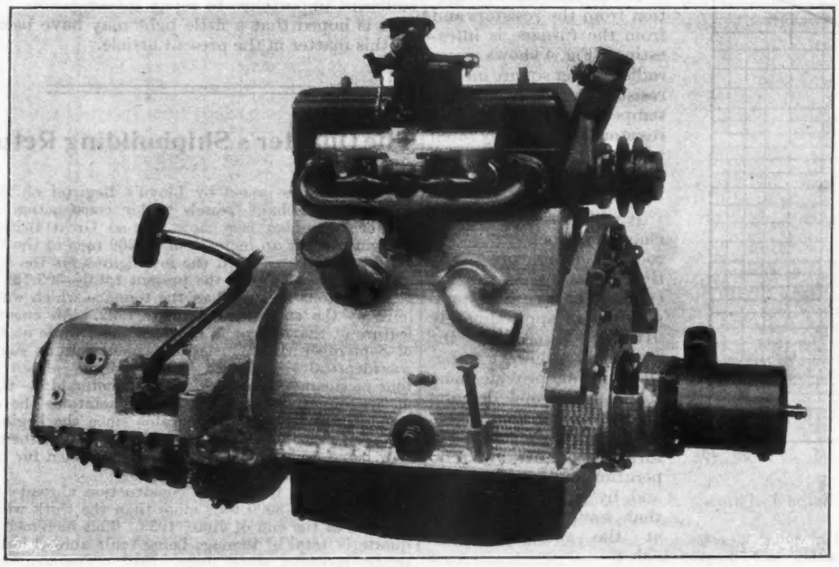


FIG. 3—FOUR-CYLINDER 12·8 H.P. ENGINE—SUNBEAM

Improvements in details of engines include accessible and replaceable oil filters, air cleaners, induction silencers, and downdraught carburetters, with some form of auxiliary starting device for giving a better "pick-up" or acceleration. The fuel feed is generally by some form of positive pump driven off the engine. The Humber Company is introducing quite a number of automatic refinements in connection with the power units. For instance, the ordinary hand strangler, which is liable to abuse by inexperienced drivers, is replaced by a device by which the strength of the mixture of air and petrol vapour is regulated automatically as the engine warms up. Another improvement has been introduced by which the radiator shutters are closed quickly when the engine is stopped. This is not done by the usual thermostat, which is also fitted, but is effected by the engine pressure lubrication system. To prevent excessive cylinder wear it is now a fairly common practice to introduce a special lubricant along with the mixture of petrol vapour and air. The Rolls-Royce Company obtains this effect by automatically admitting a lubricant direct to the cylinder walls only when the starter carburetter is used; that is, when the lubricant is chiefly required. The synchro-mesh gear-box fitted by Rolls-Royce has also an easy change mechanism applied to the second, third, and top gears. The compression ratio of the 40–50 H.P. engine has been increased, giving more power for a given area and a semi-expanding carburetter is introduced.

The Alvis Company is usually to the fore in original ideas, and this year it is showing new features in a 20 horse-power car. Perhaps the most striking feature is the method of spring suspension of the front of the car to give independent springing to each wheel, as in the case of the Sunbeam car mentioned above. This is done by the use of a laminated half-elliptic spring attached crosswise above a rigid transverse member at the front of the frame. Each end of the spring is attached by a shackle bolt to a steel bracket which forms the fulcrum point for the steering pivot. At the bottom of this bracket another shackle pin attaches it to a triangular radius member, the base of the triangle being attached to the frame by a swivel in which is a shock absorber. The deflection of the spring causes the steering pivot and stub axle to rise and fall in a vertical plane. The location of the steering pivot is secured partly by the spring and partly by the triangular radius member. The steering of each wheel is also independent. From each steering pivot a drag link runs to a bell-crank on the frame and the two bell-cranks are coupled together by a track rod, which is also carried on the frame and is coupled up to the Marles-Weller steering gear. The Alvis car has a four-speed gear-box, in which all the gears are of the synchro-mesh type. Helical toothed wheels are used for constant-mesh third and second speeds and straight-tooth wheels for the low gear and reverse. Lubrication of the gear-box is by means of an oscillating plunger pump which forces oil under pressure through the length of the shaft to the gear wheels and bearings.

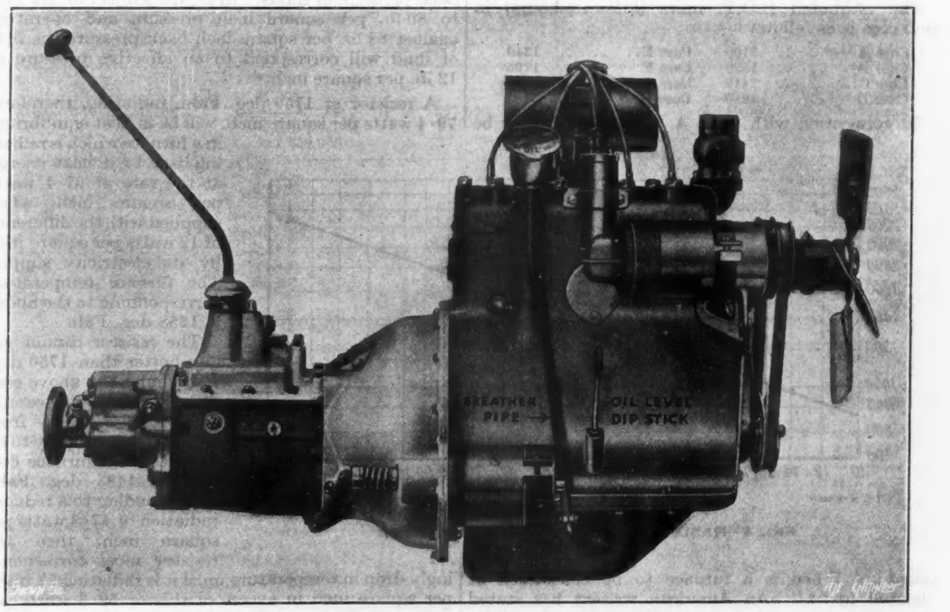


FIG. 4—10 H.P. ENGINE AND GEAR BOX—STANDARD

STANDARD.

The Standard Company's range of cars embodies many important changes in design, not the least of which is the adoption of synchro-mesh gears on the second, third, and top speeds with a controlled free-wheel device. This gives more silent and faster changes of gear. Other new features include the Startix automatic re-starting device in the engine, compensated voltage control of the dynamo, and on the larger cars a four-wheel jacking system. The chassis frame is reinforced by cross bracing. The 9, 10, and 12 horse-power cars are all fitted with improved four-cylinder engines with side valves, aluminium pistons and machined combustion chambers and ports. The engines are all mounted on rubber cushions. A feature which should not be passed over without mention is an accessible oil filler and dip stick for the gear-box. Views of the 10 horse-power engine and gear-box assembly and free-wheel mechanism are given in Figs. 4 and 5.

WOLSELEY.

The Wolseley 1934 programme includes a new 9 H.P. car with an overhead cam shaft four-cylinder engine, gear-box with synchro-mesh top and third speeds, and Pedomatic starting, enabling the engine to be started by the depression of the accelerator pedal. The Hornet models have six-cylinder engines, free wheel transmission, synchro-mesh gears, an underslung double frame and Startix automatic starter mechanism. The 16 horse-power car transmission system now incorporates a free wheel and a vacuum operated clutch which can be put in or out of action as desired. The engine has centre-seal pistons and centri-cast cylinder liners.

DAIMLER AND LANCHESTER.

Fluid fly-wheel transmission combined with the Wilson self-changing gear-box form the main feature of the Daimler and Lanchester exhibits. The 15 H.P. and 20 H.P. Daimler cars have overhead valve engines, while the 25 H.P. and 40 H.P. cars have sleeve valve engines, the latter having twelve cylinders. The associated Lanchester firm confines its energies to 10 and 18 horse-power vehicles, with overhead valve engines having four and six cylinders respectively. They embody the fluid fly-wheel and Wilson gear-box. The B.S.A. company is concentrating on the 10 H.P. car, which has a four-cylinder side valve engine and transmission of the same type as that employed by the Daimler and Lanchester firms. We are informed that over 9000 cars have now been fitted with the fluid fly-wheel transmission system.

RILEY.

Some of the Riley cars, both 9 H.P. and 14 H.P., are fitted with preselector gears and the Newton automatic clutch, which is controlled by centrifugal force. The arrangement is such that the drive is not taken up until a certain engine speed is attained, this being in the neighbourhood of 500 revolutions per minute. In practice the result is that by releasing the accelerator and momentarily depressing the clutch a free-wheel action is obtained. If this is not desired, the engine retains its retarding effect until the car is almost at a standstill. A new type of chassis frame of box section is now used on the 9 H.P. cars.

AUSTIN.

The Austin Motor Company has a wide range of cars from the popular 7 H.P. upwards. The 7 H.P. and 10 H.P. cars have four cylinders, but those rated at 12 H.P. have either four or six cylinders, all with synchro-mesh transmission. One of the chief attractions of the Show is the model of the Hayes "self-selector" transmission system which can be fitted on the 16 H.P. Austin cars as an extra. This is an automatic friction drive device, which makes driving as simple as can possibly be wished. The Hayes gear, Fig. 6, is claimed to be infinitely variable and fully self-acting. The actual transmission is through steel rollers, which transfer the drive between curved steel races, the gear ratio being altered by rocking the rollers to different positions of contact. There are no gear wheels, except for reversing the motion of the car, and the drive is silent. The variation in ratio from 4 to 1 to an overgear 1 to 1·7 is greater than is provided in the normal transmission systems employing toothed gears. On down gradients the overgear is equivalent to a free wheel, but without the disadvantage of disengagement of the engine, and the full braking effect of the engine is available by operating a simple control lever. The driving rollers referred to above are rocked by hydraulic means and finger tip controls enable the driver to vary the running of the car, either to give exceptional performance or utmost economy. Subject to the control setting, the automatic operation of this ingenious gear ensures a constant engine speed whatever the tractive resistance met with on the road, the transmission varying its ratio to balance the resistance as this increases or decreases. In this manner, with the control suitably set for automatc operation, the driver has only to operate the accelerator. The sectional view shows the clutch shaft 1 from which the drive is taken through the dogs to the driving shaft 2 and the two outer races 3 and 4. The rollers 5, of which there are two sets of three, are mounted in a fixed assembly 6, and by rotating transfer the drive to the centre race 7, and thence through the drum 8 to the propeller shaft. The rocking of the rollers to give varying ratios, due to different contact diameters on the driving and driven members, is initiated by the control sleeve 12. Spring washers 9 and the balls between the torque ring 10 and the outer race 3, which wedge in inclined grooves, provide the pressure on the assembly necessary for the transmission of the drive. With this automatic transmission, when starting it is merely necessary to push a lever forward, let in the clutch and press the accelerator, when the car gains speed. By taking the foot off the accelerator the effect is similar to that of lowering the gear ratio, and *vice versâ*.

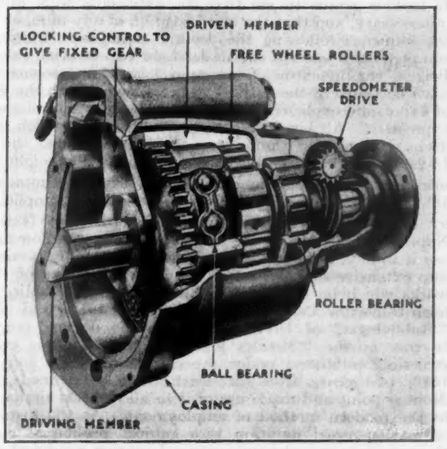
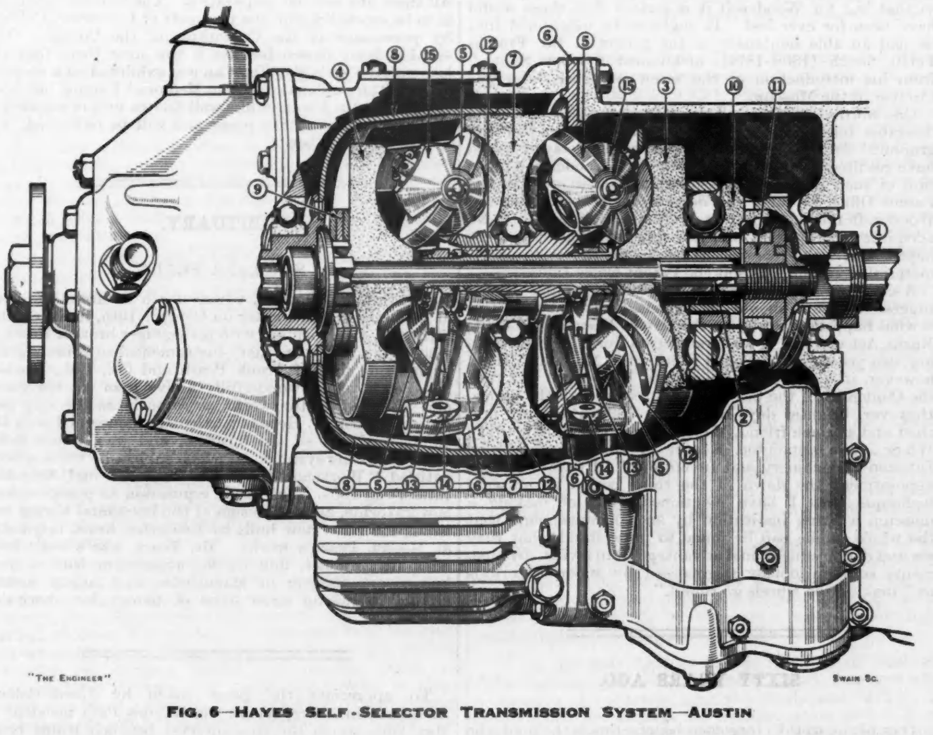


FIG. 5—FREE-WHEEL MECHANISM—STANDARD



"The Engineer" Swain Sc.

FIG. 6—HAYES SELF-SELECTOR TRANSMISSION SYSTEM—AUSTIN

Morris.

The range of Morris cars for 1934 includes the 8 H.P. Morris Minor, 10 H.P. four-cylinder, 11·9 H.P. four-cylinder, 12 H.P. four-cylinder, 15 H.P. six-cylinder, 16 H.P. six-cylinder, and 18 and 25 H.P. six-cylinder cars. All of these have four-speed synchro-mesh gear-boxes in unit construction with the engines, giving an easy change of speed on the third and top. From the 10 horse-power car upwards new stiffened frames are provided with cruciform bracing. The four-cylinder Morris 10 H.P. car makes a strong appeal to users of "moderate means." It is a coach-built saloon with sliding head. The engine has a capacity of 1292 c.cm., and has a detachable head with air cleaner, preheater, and fume consumer. The engine has forced lubrication to the main bearings and side valves, coil ignition with automatic advance, finger-tip controls for ignition, driving, &c. The brakes are hydraulically operated and the steering is by cam. Armstrong hydraulic shock-absorbers are fitted to the suspension system.

Accessories and Components.

In many respects the accessories and components section of the Exhibition is more attractive than the car section. The exhibitors in this section comprise the makers of the many individual parts upon which the operation of the cars depends, such as carburetters, ignition devices, engine details, and lubrication equipment. In this department the Triplex Safety Glass Company, Ltd., shows a new kind of toughened glass which, when broken, crumbles into small fragments. This glass does not become discoloured with long usage in hot countries, nor does it blister as is the case with some makes of laminated glass. Within limits it can be twisted and bent without fracture, and it will withstand heavy blows. The A.C.-Sphinx Sparking Plug Company, Ltd., Birmingham, has an attractive display, including plugs of various kinds, oil filters, petrol pumps, air cleaners, gauges and speedometers. The necessity for clean air in the fuel mixture is being increasingly recognised if cylinder wear is to be minimised, and the A.C. Company makes centrifugal and oil-wetted cleaners. In the former the air is made to revolve by means of fixed blades, and the particles of dust are ejected through a slot in the body of the cleaner. In the oil-wetted type the air passes through woven metallic mesh soaked in oil, which retains the dust particles. There is a third type which combines an intake silencer and air cleaner in which, by the use of harmonic principles, secondary sound waves are set up within the silencer to nullify the intake roar. This device has to be designed and tuned to suit each individual induction system, and is therefore a fitment for the car manufacturers rather than for adoption by the users.

Simms Motor Units, Ltd., Gresse-street, Rathbone-place, W.1, shows a range of new atomisers and fuel injection pumps for compression-ignition engines which have several original features. In the atomisers there are three outstanding features—a detachable nozzle cap, a protected needle guide, and a screw-operated ball relief valve to expel the air from the fuel pipe system. The fuel pump operates on the "jerk" system, in which an accurately metered quantity of fuel oil is introduced into the pump chamber before the commencement of the working stroke. By cam action the plunger is thrust upwards, thus discharging the contained oil through a delivery valve, delivery pipe, and atomiser into the engine combustion chamber.

In the service and garage section of the Show, Tangyes, Ltd., Birmingham, have a stand on which are exhibited a hydraulic car lift, a range of air compressors with a special centrifugal unloading device, car-washing pumps, oil engine generating sets and greasing outfits.

Examples of modern chain-driven systems in operation are shown by the Renold and Coventry Chain Company, Ltd. Interesting features of this firm's exhibits are the methods of adjustment of the chains, of which there are three types, designed to give quiet running and long life of the chain. The designs consist of self-contained units complete with fixing means, chain wheels and bearings, and it is necessary only to provide for suitable fixing bosses adjacent to the chain drive for holding the auto-adjuster bases. The principle of operation is to urge forward by gentle spring pressure the chain wheel in contact with the chain. A ratchet device prevents the return of the chain wheel and all danger of overstraining the chain due to heat expansion is eliminated by the design of the ratchet mechanism, which includes a sufficient margin of "lost motion" after operation.

Technical Museums.*

By H. W. DICKINSON.

The earliest conception of a technical museum, and at the same time the first breakaway from the seventeenth century idea, so far as I have been able to find, emanated from the brain of that celebrated philosopher Francis Bacon, Viscount St. Albans (1561–1626). His "New Atlantis," written in 1625, left unfinished and not published till 1627, gives an account of an imaginary commonwealth or "Utopia." A former king of the Island Atlantis had founded an order or society known as Salamon's House. One of its Fellows favoured Bacon with an account of it: "Sonne, to make you know the true state of Salamon's House, I will keepe this order. First I will set forth unto you the End of our Foundation. Secondly, the Preparations and Instruments we have for our Workes. Thirdly the severall Employments and Functions whereto our Fellowes are assigned. And fourthly, the Ordinances and Rites which we observe."

I will only quote part of the "fourthly," although the whole is worth reading. "For our Ordinances and Rites: Wee have two very long and Faire Galleries: In one of these we place Patterns and Samples of all manner of the more Rare and Excellent: Inventions: In the other wee place the Statua's of all Principall Inventours. There wee have the Statua of your Columbus, that discovered the West Indies: Also the Inventour of Shipps; Your Monke that was the Inventor of Ordnance, and of Gunpowder; The Inventour of Musick; The Inventour of Letters: The Inventour of Printing: The Inventour of Observations of Astronomy; The Inventour of Works in Mettall: The Inventour of Glasse: The Inventour of Silke of the Worme: The Inventour of Wine: The Inventour of Corne and Bread: The Inventour of Sugars; And all these, by more certaine Tradition, than you have. Then have we diverse Inventours of our Own of Excellent Workes: Which since you have not seene, it were too long to make Descriptions of them; And besides, in the right Vnderstanding of those Descriptions, you might easily erre. For upon every Invention of Valew, wee erect a Statua to the Inventour, and give him a Liberall and Honourable Reward. These Statua's are some of Brasse: some of Marble and Touchstone; some of Cedar and other speciall Woods, guilt and adorned; some of Iron; some of Silver; some of Gold."

It will be observed that Bacon's idea was to have a museum of inventions and a portrait gallery of inventors; they were to be in long galleries—quite a modern touch—and as much space was to be devoted to commemorating the "Principall Inventours" as to illustrating their "Rare and Excellent Inventions." The "Atlantis" is only an airy fantasy, but we shall find later how Bacon's ideas were reduced to practice.

An early suggestion for a museum of a technical character occurs in a letter from Samuel Hartlib to Robert Boyle in 1649: "Fauxhall is to be sett apart for publick uses, by which is meant making it a place of resort for artists, mechanicks &c and a depot for models and philosophicall apparatus," adding that the late King (*i.e.*, Charles I.) "designed Fauxhall for such an use." It had recently been a small arms factory. Nothing, however, came of the suggestion.

René Descartes (1596–1659) in France made a similar suggestion of collections for the instruction of artisans. Perhaps the earliest collection of mechanical apparatus was the cabinet of Nicholas Grollier de Serviere, of Lyons (1596–1689). I do not know what happened to this cabinet.

My attention has been drawn by Mr. Gomme to a rare book, "Explication des Modeles des Machines et forces mouvantes que l'on expose à Paris dans la rue de la Harpe vis-a-vis Saint Cosime," 1683, 4to, in which are described and illustrated twelve models apparently in a public museum; other models are stated to be in preparation. Nothing whatever is known of the origin or fate of this experiment; I can only suggest that it was before its time.

In the eighteenth century the growth of trade and industry brought about the formation of technical societies, of which we need only mention as typical the Society for the Encouragement of Arts, Manufactures and Commerce, founded in 1754. Its purpose was to award premiums for meritorious discoveries and inventions. Till

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* From the Presidential Address, Newcomen Society for the Study of the History of Engineering and Technology Oct. 11, 1933.

1845 it was a condition of the premium that the article should not have been patented. The Society's first exhibition—of agricultural and other machines—probably the earliest industrial exhibition anywhere, was held in 1761. Thereafter the Society kept up a permanent "Repository" of machines that had been premiated, available to the public by an order from a member. The collection was weeded out from time to time, but when the Society began to hold temporary exhibitions and space was needed the models had to go; we shall record their fate later. As a guide to search, it is worth mentioning that a "Description of the . . . Machines . . . in the Repository" was published in 1772 by William Bailey. A classified catalogue appeared in 1814.

Patent Office Museums.

We have now to consider another aspect, that of the registration of technical advance by means of models of patented inventions and for this we have to turn to the United States. The first enactment of a patent law by Congress was in 1790, and both in this and in the Act of 1793 the Secretary of State, if he thought fit, could call upon the patentee to deposit a model of his invention—really to serve as an amplification of the specification. A classified list published in 1823 shows that there were then 1819 models in existence. They increased rapidly, but, to the number of about 7000, were swept away with all other records in the disastrous fire on December 15th, 1836; much was done to replace them in the succeeding decade. As time went on patentees reduced their models to minimum requirements, with the vast increase of patents the demands upon space became enormous, and the opinion hardened that they were not really necessary. Hence the law of 1870 did not require a model to be furnished, but still many were made. In 1891 there were 154,000 in existence; since then the practice has been discontinued altogether.

Parallel with the development in the United States, one of another character was going on in France, brought about by that outburst of the human spirit, the French Revolution. Influenced possibly by the Encyclopædists, the idea was broached of founding a technical museum coupled with a teaching body of wide scope. The decree of the 19 Vendemière an III (October 10th, 1794) recites: "Art. ler.—Il sera formé à Paris sous le nom de Conservatoire des Arts et Métiers et sous l'inspection de la Commission d'agriculture et des arts, un depôt public de machines, modèles, outils, dessins, descriptions et livres de tous les genres d'art et métiers; l'original des instruments et machines inventés et perfectionnés sera deposé au Conservatoire.

"Art. 2me.—On y expliquera la construction et l'emploi des outils et machines, utiles aux arts et métiers."

The Conservatoire started with two valuable nuclei. One was the collection of machines formed by Jacques de Vaucanson (1709–1782), the well-known mechanician, and thrown open by him to the public in 1775. At his death he bequeathed his machines to King Louis XVI. The other nucleus was the apparatus collected during the first century of its existence by the Académie Royal des Sciences. These objects had only been known up to that time through the publication of "Machines Approuvées," 1735, six volumes, which is such a mine of information to us to-day.

After much deliberation as to the future home of the Conservatoire, the Directory ordered that the buildings of the sequestered Priory of St. Martin-des-Champs, then used as a small arms factory, should be allocated for the collection. Thither they were removed in April, 1799, and there they have remained to this day. It was not till 1819 that full effect was given to Article 2me of its constitution by the inauguration of courses of public lectures, a feature that has been considerably extended since. Testing laboratories, too, have been added.

To return to England, we find in the early part of the nineteenth century great public interest being taken in the mechanic arts, due to influences which are too well known to need recapitulation. By the middle of the century the advance in ideas that I have mentioned above came about, *i.e.*, that a museum should have as its aim the advancement of specific knowledge. I have not traced this idea to any particular individual, and possibly it arose gradually by an extension of the idea underlying teaching and reference collections accumulated in colleges and universities, such as the Hunterian Museum (1795) of the Royal College of Surgeons in London.

Impetus was given to the idea by the Great Exhibition of All Nations of 1851. A surplus resulted from it, and this, under the directing advice of H.R.H. Prince Albert, was devoted as one outlet to the foundation in 1857 of the South Kensington Museum. Its aim was to promote the application of art and industry and to illustrate the progress and development of science. Obviously, a new attitude towards the kind of object admissible to such a museum had to be adopted. Nothing is eligible that is not justified as part of a considered scheme.

Parenthetically, it may be observed that the name museum, associated as it still is in the public mind with the seventeenth century concept, quite fails to cover this development; in spite of all efforts, however, no better name has been found.

Bennet Woodcroft.

I must now introduce you to a man whom I consider in a sense one of the founders of this Society—Bennet Woodcroft (1803–1877), F.R.S., himself an inventor, Professor of Machinery at University College, London. To him in that capacity the bulk of the models from the Society of Arts Repository had been presented. He had occupied the post for four years when he was appointed Superintendent of Specifications, an office created under the Patent Law Amendment Act of 1851. He entered upon his duties in December, 1852, and at once displayed great zeal and energy in rendering available to inventors the materials relating to inventions in the custody of the Master of the Rolls. In particular, he succeeded in inducing the Commissioners to print the Letters Patent for inventions, with specifications when such were enrolled, from 1617 onwards. We have therefore him to thank for making available a corpus of information of the utmost value to our historical studies. It will interest members to know that the pre-1617 patents have been similarly taken in hand by some of our members, and it is profoundly to be hoped that, when completed, funds will be made available for their publication.

Woodcroft brought with him to the office his library of books and his collection of mechanical models. The first formed the nucleus of the Patent Office Library, and the second that of the Patent Museum. We are concerned only with the latter. I have not come across a public statement of its aims, but they were obviously based on Bacon's fantasy, with which Woodcroft was familiar. In short, he determined to make Bacon concrete. His diary shows that he had the approbation of H.R.H. Prince Albert, and it was probably through his influence that Woodcroft got permission from the 1851 Commissioners to house his collection in the buildings of the South Kensington Museum, opened in 1857. Woodcroft objected to the charge of 6d. on students' days, and Sir Henry Cole, the Director, would not yield, so that the Patent Museum was housed from 1857 to 1883 in unsightly iron buildings, irreverently known as the "Brompton boilers."

Woodcroft was well qualified for his post, and knew what he wanted. He soon began searches for masterpieces of invention, and made efforts to recover objects known to have been in existence, such as Lombe's silk-throwing machines, patented in 1718, examples of which were deposited in the Tower of London by Act of Parliament in 1741. He was successful in recovering some fragments.

One of his boldest attempts was to recover the Marquis of Worcester's "water commanding engine." Woodcroft circulated (1860) to all likely departments and persons a lithographed appeal, but without success. Now in "The Century of Inventions," Art. 98, the Marquis said of it: "I call this A Semi omnipotent Engine and do intend a Model thereof to be buried with me." Consequently, Woodcroft concluded that the thing to do was to open the Marquis' coffin, which was in the family vault in Raglan Church, Monmouthshire. Having obtained after much trouble the permission of the ecclesiastical authorities and of the family, he, accompanied by John Macgregor (1825–1892), barrister of the Inner Temple, best known subsequently as "Rob Roy," on January 4th, 1861, visited the church, opened the vault and the coffin, but found no model there. A full account, with sketches of this gruesome search, is preserved in the Science Museum and at the Patent Office Library. I will only quote one sentence from this unique document: "Out of respect to the remains of the mighty dead, we did not open the cloth over the face, but were satisfied that there was no model buried in that part of the coffin." Woodcroft's intention had leaked out, and to his annoyance comments had appeared in the Press in the June and July previous, but the actual deed was done in secrecy, and to this day is only known to a few persons.

In other quests Woodcroft was more successful, and through his exertions we owe the preservation of Watt's first pumping engine, "Old Bess," 1777; Watt's rotative engine, the "Lap engine," 1788; Arkwright's cotton machinery, 1769–1780; Symington's marine engine, 1788; Bell's "Comet" marine engine, 1812; "Puffing Billy," 1812, and the "Rocket" 1829, locomotives; Bell's reaping machine, 1826; and many other objects of less importance, but all of them documents of the highest value to us, and not approached anywhere else in the world. At that time such objects were not appreciated, and more than one of them was actually on the scrap heap, so that but for Woodcroft it is certain that these would have been for ever lost. It ought to be mentioned that he had an able lieutenant in the person of Sir Francis Pettit Smith (1808–1874), nicknamed "Screw Smith," from his introduction of the screw propeller, who was Curator of the Museum.

One word about the Gallery of Inventors—it sounded a desirable human note, and led to research in the biographical field, which had it been longer delayed would have resulted in much being lost. The Woodcroft Collection of such information is preserved fortunately in the Patent Office Library, and deserves to be better known. Woodcroft retired at last in 1876 and died in 1879. No adequate biography of him has appeared, and it is to be hoped that some member will take up the task, ample material for which exists at the Patent Office Library.

A cloud now settled over the Patent Museum. It was suggested that it should be abolished, and, in fact, this is what happened, for under the Patent Designs and Trade Marks Act of 1883, it was transferred during the succeeding two years to the South Kensington Museum. Here, however, it was in no happier state, for science was then the Cinderella of the piece and art received all the plums. However, brighter days dawned in 1890 when my first chief and staunch friend, William Isaac Last (1857–1911), Wh.Sc., was appointed Keeper of the hybrid-entitled Division "Machinery and Inventions." I date from this appointment the dawn of the third period in museum technique that I have mentioned, that of making a museum a living institution by such arrangements that the whole public can be made to understand what they see and derive educational advantage from a visit, arrangements contemptuously stigmatised by superior persons as "making the wheels go round."

SIXTY YEARS AGO.

One of the world's forgotten benefactors is the man who invented the decimal point in arithmetic. Very few people, it may here be remarked, seem to be aware that it is not the same thing as the full point(.) which we put at the end of our sentences nor the full point turned upside down (·), but a special symbol (·) all by itself, higher than the one and lower than the other. This typographical discrimination is not always observed, but the fact that it exists may be taken as a mark of the importance and dignity which we should attach to the decimal point. It is certainly worthy of all the respect which we can give it. It is much more than merely a separator dividing integers from fractions. A mere comma might equally well have served that purpose. Actually, it implies that the figure immediately following it is to be read as so many tenths, the second figure as so many hundredths, and so on. It is so simple and obvious to-day that it is almost impossible to believe that the use of the decimal point did not come automatically into use as soon as man began to express fractions in terms of tenths, hundredths, and so forth. Yet it did not do so. Like many another great invention, it passed through early complex stages before it reached its final simplicity. Decimal arithmetic is commonly believed to have been invented by Simon Stevin, of Bruges, round about 1585. His system of notation was, however, just about as cumbersome as it well could have been. He wrote the number 18·2468—pronounced "eighteen point two four six eight"—as 18 (0) 2 (1) 4 (2) 6 (3) 8 (4), but used complete circles where we have used parentheses—and pronounced it as "eighteen commencements two primes four seconds six thirds and eight fourths." The numbers in brackets indicated the exponents of one-tenth which were to be used to form the multiplier of the unbracketed numbers preceding them. This idea persisted for a long time in a variety of forms, a common one being $18, 2^{I}4^{II}6^{III}8^{IV}$. It took a genius to see that the exponents were quite unnecessary, and that the mere position of any number in the sequence following the decimal point was sufficient completely to specify the understood exponential value. Briggs, the inventor of common logarithms, seems to have been one of the earliest to break away from the use of exponents explicitly inserted in a decimal arithmetical expression. All his life he used a notation in which the decimal portion of the expression was underlined thus: $18\ \underline{2468}$. Oughtred avoided the ambiguity which might be introduced by careless underlining by using the notation $18\,/\,\underline{2468}$. But, even so, they were forestalled in simplicity by Napier, the inventor of natural logarithms. It was Napier who introduced the decimal point as we know and use it to-day, although it was many years before it came into extensive employment. Actually in neither of the works which he published in his lifetime—the "Mirifici logarithmorum Canonis descriptio," of 1614, and the "Rabdologia," of 1617—did he use the decimal point. It was in the "Mirifici logarithmorum Canonis constructio," published under the editorship of his son in 1619, two years after his death, that he defined the decimal point and made use of it in all respects similarly to the modern method of employment. As the history of mathematical notation is a subject prolific of controversy—witness the international tension produced by Newton's and Leibnitz's quarrel concerning the notation of the calculus—we wish to make it clear that the statements in this note are made on the responsibility of a paper read before the British Association in 1873 by Mr. J. W. L. Glaisher, and reprinted in our issue of October 24th of that year.

TREVITHICK CENTENARY.

The Trevithick Centenary Commemoration Committee has now in hand or promised sufficient funds to enable it to carry out in a modest way the purposes which it it had in view when it was constituted last October. These aims are a Memorial of Trevithick's London locomotive of 1808, in London; a Monument on the line of track of his South Wales locomotive, 1803, at Penydaren; and a Tablet at his birthplace, 1771, in Illogan Parish, Cornwall. All these are now in preparation. The London Memorial is to be erected within the precincts of University College, by permission of the Committee of the College. The site has been chosen because it was near there that the locomotive Catch-Me-Who-Can was exhibited on a circular track. The publication of the Memorial Volume has been ensured by the kindness of a well-known firm of engineers; the work is now in the press, and will be published, it is hoped, in December.

OBITUARY.

SINCLAIR PEARN.

Mr. Sinclair Pearn, whose death occurred suddenly at his home in Manchester on October 10th, in his eighty-fifth year, was, together with his younger brother Frank—who died some years ago—instrumental in founding the engineering firm of Frank Pearn and Co., Ltd., Gorton. Mr. Pearn was a wonderfully active man for his years, and attended at the works as recently as the day preceding his death. He was particularly concerned with the commercial side of the business, and was keenly interested in costing systems, on which subject he wrote a book entitled "Workshop Costs for Engineers and Manufacturers," in 1905. The firm's reputation as pump makers is world-wide, and the design of the horizontal boring and facing machine, now built by two other firms, originated at Messrs. Pearn's works. Mr. Pearn was a very keen amateur gardener, and by his association with a well-known organisation in Manchester was largely instrumental in raising large sums of money for charitable causes.

To appreciate the point made by Lieut.-Colonel Anderson, in his report on the Raynes Park accident of May 25th, as to the time-interval between trains being considered, when lifting a road, as well as the height of the lift, it should be said that the only rule specifically referring to lifting the track is No. 224. That rule, moreover, only says that no lift must be greater than 3in. at once. Then, in Rule 217 (*g*), lifting is named as one of the works that may call for a speed of 15 m.p.h., or such other reduced speed as may be prescribed, and for such work a flagman must be stationed to secure the reduced speed. No intimation is given in the latter rule as to what degree of work would make it necessary for the train to travel at reduced speed, whilst Rule 224 appears to imply that a lift of 3in. or less is safe. There was also the matter of time between trains. In this case it was ten minutes, and by the time the train approached three or four lifts had been made of the rail in question, but the last lift could not be completed, and some sleepers were quite unsupported.

Railway and Road Matters.

The London Passenger Transport Arbitration Tribunal has entered into occupation of its offices at Columbia House, Aldwych, W.C.2 (telephone number, Holborn 7305). Mr. Paul C. Davie, Barrister-at-Law, is Secretary.

After two days' trial at Carlisle Assizes, the porter-signalman charged with manslaughter as a consequence of the Little Salkeld accident of July 10th, was acquitted on October 11th. It was given in evidence that the man was still in the service of the railway company.

During the railway strike in Ireland last February a Great Northern express was derailed at Dromiskin, and two people killed. The railway company made a claim for £15,000 against the Louth County Council, which came before the Dundalk Circuit Court on October 11th, when judgment was given for £7450.

The through service between the former Metropolitan District Railway, also the Piccadilly tube, and Uxbridge, which is on what was the Metropolitan, to which we referred on September 15th, will be opened on October 23rd. The two companies' lines terminated in South Harrow Station, where a change of trains used to be necessary.

Representatives of the railway companies and of the three railway unions met on Tuesday, the 17th, to discuss some new conciliation machinery to take the place of the National Wages Board. It will be remembered that, at the beginning of the year, the railway companies gave twelve months' notice of their intention to retire from the present scheme.

The Ministry of Transport railway statistics for June also gave the results for the first six months of the year. These show that, compared with the corresponding period of 1932, the number of passenger journeys increased by 0·4 per cent., but the receipts therefrom fell by 0·8 per cent., and the total passenger traffic receipts by 1·0 per cent. The tonnage of freight had a drop of 3·7 per cent. and the freight traffic receipts were down by 5·6 per cent, Of these two figures, merchandise was reduced by 5·2 and 5·8 per cent. respectively. Freight train-miles were reduced by 2·8 per cent.; the average train load fell from 121¼ to 120¼, and the net ton-miles per engine-hour from 446¾ to 445¼.

The collision of June 17th, between a Leeds and Bristol express and a mineral train, which was referred to herein on October 13th, has generally been referred to as the Ambergate collision. We have, however, preferred to give it the name of the signal-box—Crich Junction—at which it occurred. We have done that out of compliment to George Stephenson, who, when building the North Midland Railway, got his Liverpool friends to establish the well-known Clay Cross Collieries and to build lime kilns at Ambergate. The limestone quarries are at Crich, and the stone was conveyed—and it is still—by an inclined plane 3 miles long. At the foot of the incline is the Cromford Canal, to which reference was made on page 361 of our issue of October 13th. It was at Tapton House, Chesterfield, some 15 miles from Crich, that Stephenson died.

Mention was made in the Press recently of the extensions being made by the Wandsworth and District Gas Company at its works at Wandsworth. These works are of interest to railway students as being the scene of the commencement of the Surrey Iron Railway, the first railway opened for the conveyance of the traffic of the public, and not alone that of certain individuals, *e.g.*, colliery owners, canal companies, &c. The line was sanctioned in 1801, and was from a dock or basin in Wandsworth Creek at or near a place called the Ram Field. The creek in question is where the river Wandle enters the Thames, and is now the property of the above-named company. In The Engineer of January 5th, 1900, was an article on the Surrey Iron Railway, and the lock gates, a crane, and some other items of the original work were illustrated.

It was seventy years, on October 1st, since the Great Northern trains began to run over the Metropolitan Railway from King's Cross to Farringdon-street by means of a junction with what is now the Inner Circle line. On February 17th, 1868, the two lines outside the Inner Circle, always known as the widened lines, were brought into use and the junction with the Great Northern was then transferred to the widened lines. To complete this particular point in railway history, it may be added that on July 13th, 1868, the Midland Railway opened its Bedford and London extension throughout for passenger traffic. Part of that extension was a connection from near Camden-road Station to the Metropolitan at King's Cross at, practically, the junction with the Great Northern. As the Midland terminus at St. Pancras was not ready to receive traffic, the trains ran over the Metropolitan to and from Moorgate.

The death recently of Sir George Beaumont, of Cole Orton Hall, Ashby-de-la-Zouch, prompts a reference to two of his ancestors. At the end of the sixteenth century, one, Huntingdon Beaumont, was sent by his father, Nicholas Beaumont, who was said to be the then largest coal-owner in Leicestershire, to Germany. Thence, according to William Gray's *Chorographia* (1649), he brought back "many rare engines not known in these parts, such as . . . waggons with one horse to carry down coals from the pits to the staithes on the river." Huntingdon Beaumont was concerned with others in the development of coalfields near Bedlington, in Northumberland. He was spoken of as "of Bilborough, near Nottingham." That place is near Wollaton Hall, the seat of the Middleton family, whose papers were recorded by the Historical Manuscript Commission in 1911. References therein suggest that there was a wagon way from the pits at Wollaton and in the adjoining locality of Strelley to the river Trent as far back as 1597. This implies that Huntingdon Beaumont introduced the wagon-way—the forerunner of the railway—into this country from Germany towards the end of the sixteenth century. The head of the Beaumont family in the earlier years of the nineteenth century was Sir George, of whom Abraham Rees' "Encyclopædia" (1819) said that he was "the owner of the collieries at Cole Orton, to which railways have previously been made at great expense connecting the Leicester Navigation."

Notes and Memoranda.

At the new Buzzard Point power station of the Potomac Electric Power Company the lubricating plant for the turbines is arranged in an underground fireproof chamber, and the pressure pipes are run inside welded return drain lines.

In an article on ingot slicing tools in the *Edgar Allen News*, Mr. B. H. Chambers describes some of the difficulties associated with the tipping of such tools with alloy steels. He says, however, that a technique has been evolved such that the bond between the tip and the shank is so close that the toolroom has occasionally failed to recognise that the tip had been entirely used up, and time was wasted in the machine shop in attempting to use the worn-out tools. The schooling of the grinders in the relative appearance of the sparks from the tip and the shank has, however, eliminated this drawback.

A process for the production of an artificial patina on copper has been evolved by the research laboratories of the Department of Scientific and Industrial Research. It is apparently an electrolytic process and is said to produce an effect in fifteen minutes that would require twenty years of natural exposure to create. The best results are obtained with arsenical copper, containing some ½ per cent. of arsenic, the presence of arsenic securing a better bond between the deposit and the underlying metal. Arsenical copper is also definitely more resistant to atmospheric corrosion, and an accumulation of arsenic has been shown to take place in the natural product. It is significant that, of the old copper roofs of which analyses are possible, all are arsenical.

Writing to *Power*, Mr. J. S. Carpenter, of York, Pa., says :—A small hydro-electric plant had trouble with eels getting into the racks and turbine casing, eventually clogging up the casing entirely and necessitating shut-downs for unsavory cleanings. Various measures were tried to remedy the condition, such as closer spacing of rack bars, without satisfactory results. Then someone suggested making the rack bars alive, believing this would discourage entrance of the eels. The individual bars were then insulated from each other and 55-volt alternating current connected across them. This corrected the trouble. At another plant, a cofferdam frame was built with 1in. heavy wire mesh screen confining 8in. of 1·5in. crushed stone between the two sides of the cofferdam. This gave fair results, only a few eels getting through.

Discussing the filtration of drinking water supplies in the *Engineering and Contract Record*, Mr. N. J. Howard, of Toronto, says that the introduction of artificial turbidity promises to be a feature in the future. It is well known that water high in plankton life is usually free from turbidity; in fact, microscopic organisms will not thrive in water containing finely divided silt, and the introduction of turbidity into a reservoir water at Louisville some years ago was shown to reduce rapidly the micro-organisms. Again, it has been frequently shown that water will not coagulate well if the number of organisms present is large. There is also a probability that during warm weather certain colloidal properties in water are in some way associated with poor flocculation. Mr. Howard suggests activated carbon or Fuller's earth as the means of increasing the turbidity.

The annual report of the Water Department of Singapore, Straits Settlements, contains a reference to some experiments made with a 12ft. length of 4in. internal diameter armoured rubber pipe connected to the town's water supply and immersed in the sea. Service conditions involved an internal working pressure of about 45 lb. per square inch. The rubber pipe was first immersed on December 24th, 1930, and when last inspected on October 18th, 1932, was found to be in excellent condition. It was then tested to 100 lb. per square inch without any sign of leakage or failure. The supply pipe connecting this length of rubber pipe with the rest of the distribution system has frequently failed through the corrosive action of the sea water. Various types of metal connecting pipes have been experimented with, but none of them has survived the conditions mentioned for more than four months.

Air turbines have been applied during recent years to the driving of grinding spindles, and have proved to be very convenient and reliable. They are, says Mr. J. F. Romer in *Machinery*, of such simple construction that if the principles of design were better known they would doubtless be put to many other uses. Where very high speeds and perfect balance combined with cool running are required, air turbines are superior to electric motors. They could be used, for example, to drive individual cotton-spinning spindles instead of the high-frequency electric motors commonly employed, with very little difference in efficiency and considerable reduction in the amount of heat generated; they could also be utilised in conjunction with ground gears to drive suds pumps, cream separators, and sugar centrifugals. As they can be made almost entirely of aluminium alloys, their light weight makes them ideal for portable tools.

In his Melchett Lecture to the Institute of Fuel, Sir John Cadman said :—"It has been stated, I believe with a measure of accuracy, that the production of 1 lb. of motor spirit necessitates the hydrogenation of 1·6 lb. of coal. In addition, however, coal or other fuel is consumed in the operation amounting, in relation to 1 lb. of spirit produced, to 1·6 lb. of coal. The process of hydrogenation, moreover, needs hydrogen for its accomplishment, and it may reasonably be assumed that hydrogen representing a thermal value of 8300 B.Th.U. is needed for every pound of petrol produced. In all, therefore, 48,300 B.Th.U. in coal or other fuel and hydrogen are consumed in the synthetic production of 1 lb. of motor spirit which, when it is attained, has itself a net calorific value of 18,900 B.Th.U. per pound. The ratio of potential energy consumed to that produced is, therefore approximately 2·5 to 1; or a thermal efficiency for the process of 39 per cent. And the object achieved—unlike that obtained by gasification—is the production merely of a substance which at the present time Nature itself is yielding in plethoric quantity. To judge by scientific standards, such a transformation is unnecessary and wasteful.

Miscellanea.

It has been decided to construct a dam and six power units on the Columbia River at Bonneville, Oregon, at a cost of 31,000,000 dollars.

It is proposed to put up a benzole recovery plant at the works of the Dublin Gas Company. It is intended that the benzole shall be used by the company's motor vehicles.

The new regulations under which the duty paid on fuel oil used on board coasting steamers and during trial trips may be recovered, can be obtained from H.M. Stationery Office, price 2d.

The pumping equipment of the City of Montreal has just been augmented by the addition of three 30,000,000 gallons a day centrifugal pumps, each driven by a 1900 H.P. motor taking three-phase current at 2300 volts.

The magnesite mines in the Vidourre Valley, near Salinelles, in the Department of Gard, Southern France, which have not been worked for fifty years, are again being exploited. The ore is to be used in the French mineral-oil refineries for the purification and clarification of petroleum.

It is claimed that the cargo of the s.s. "Cressington Court," which is just now being unloaded in the London Docks, is the largest cargo of soft wood ever brought into the port. She carries 2500 standards (a standard is 165 cubic feet) of Douglas fir, brought from New Westminster, British Columbia.

Notice is given that the Croydon Corporation has applied for the consent of the Minister of Transport to supply to the Southern Railway Company electricity to be used for any purposes of the railway undertaking. Notice is further given that the railway company have also applied for the consent of the Minister to use the electricity so supplied.

A second meridian of the Canadian Dominion Lands system of survey has been surveyed northerly from the international boundary to the north bank of Kamuchawie Lake in township 85, a distance of over 500 miles. This lake, which lies across the Manitoba-Saskatchewan provincial boundary, and the northern terminus of the surveyed meridian are shown on the Reindeer Lake South map sheet recently issued by the Topographical Survey, Department of the Interior, Ottawa.

It has been decided, says the *Canadian Engineer*, to proceed with the construction of five large generators at once for the Beauharnois power development. It was originally expected that these generators would not be required until about 1937, but the Canadian General Electric Company, Ltd., has decided to proceed with the contract now at its Peterborough works. These five generators are duplicates of four machines already installed. Each generator will have a capacity of 58,000 horse-power and will weigh 650 tons. They will have an outside diameter of 40ft. and an overall height of 28ft.

The Government of the Belgian Congo has, according to the *Daily Telegraph*, decided to use on a wide scale the Harris tsetse fly trap, which has been invented by Mr. Harris, entomologist to the Government of the Union of South Africa. Successful experiments have been carried out with the trap, and it is hoped that it will prove the means of controlling the deadliest scourge of the African Continent—the purely tropical disease of sleeping sickness. At the invitation of its Government, Mr. Harris has just spent three months experimenting in the Belgian Congo. He has so reduced the number of flies there that they now attack only wild animals. The trap had previously been proved harmful only to the fly carrying cattle disease.

The Official Returns rendered to the Electricity Commissioners show that 1023 million units of electricity were generated by authorised undertakers in Great Britain during the month of September, 1933, as compared with the revised figure of 923 million units in the corresponding month of 1932, representing an increase of 100 million units, or 10·8 per cent. The number of working days in the month (*i.e.*, excluding Sundays) was twenty-six, the same as last year. During the first nine months of 1933 up to the end of September the total amount of electricity generated by authorised undertakers was 9352 million units, as compared with the revised figure of 8641 million units for the corresponding period of 1932, representing an increase of 711 million units, or 8·2 per cent.

It is announced by the Plastics Group of the Society of Chemical Industry that, in view of the great and continued interest which has been shown in the Plastics Industrial Exhibition at the Science Museum, South Kensington, the display will remain open until January 15th, 1934. During the six months the Exhibition has been open no less than three-quarters of a million people have visited the Science Museum, and it is reasonable to suppose that the great majority of them have been attracted to Gallery 66, where the main display of plastics is housed. It is felt that a permanent record of the Exhibition in the form of a handbook dealing generally with all the exhibits will meet with the approval of both those in the industry and the general public. The Society of Chemical Industry hopes to be able in due course to publish such a handbook and a further announcement will be made later.

The iron ore which has just started to come into this country from Sierra Leone, and is thus an Empire product, is of similar type to that of the iron ore fields of India. It is anticipated that the average analysis of the ore will be 57 per cent. of iron in a dry state. It contains 0·04 per cent. of phosphorus, and is suited for the manufacture of foundry and basic pig iron. The deposits will be worked by open-cast quarrying. The loading installation was supplied by the Mitchell Conveyor and Transporter Company, Ltd., of London; the railway has been equipped with powerful "Garratt" locomotives by Beyer, Peacock and Co., Ltd., of Manchester; and the wagons were supplied by the Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd. All plant, machinery, tools, and stores used in the construction of the railway and the loading installation and in the equipment of the mine are of British origin and were shipped to Sierra Leone in British steamers.

FABRICATING STEEL PIPES FOR THE HOOVER DAM

(For description see page 374.)

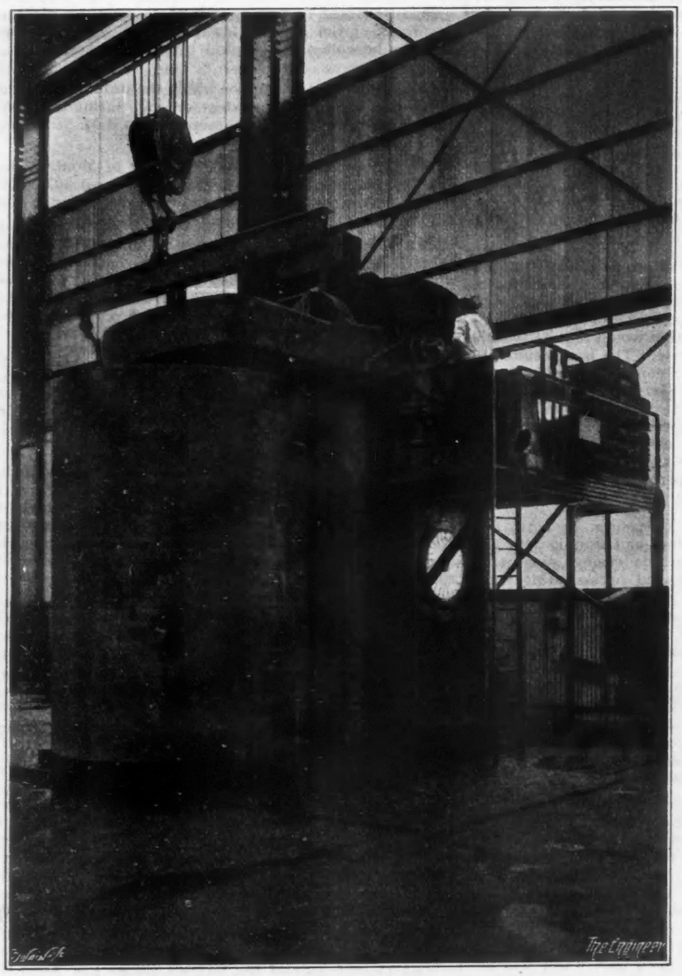
The Engineer

Fig. 7—Plate Bending Rolls

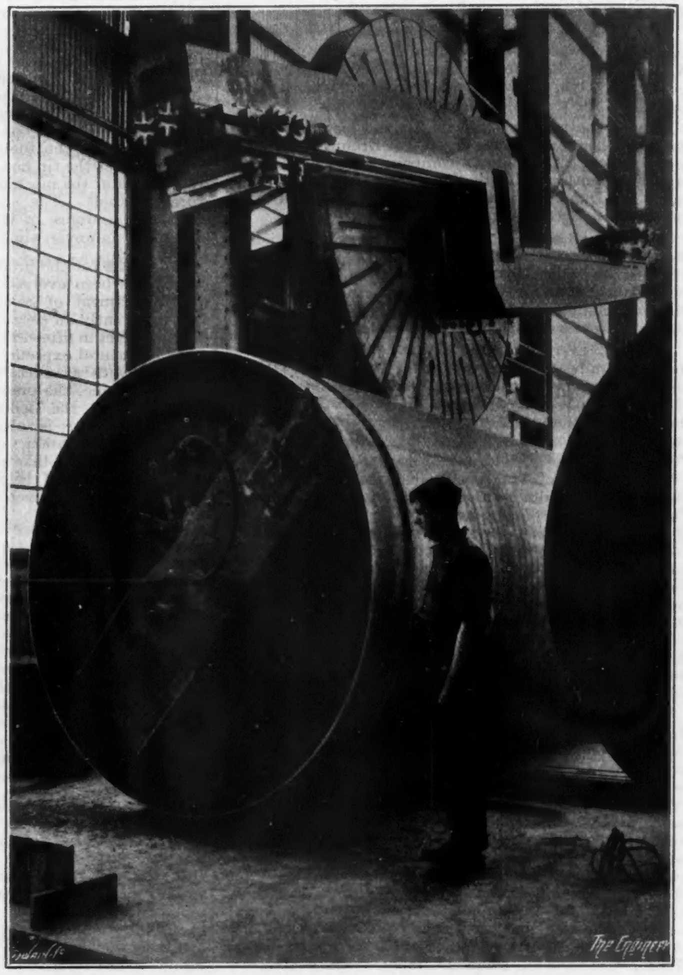
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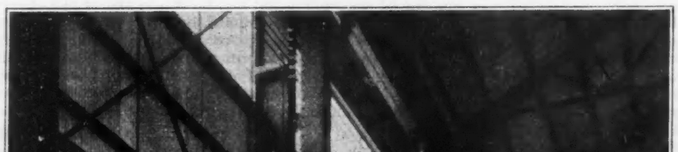
Fig. 8—Machining the End of an 8½ft. Pipe Section



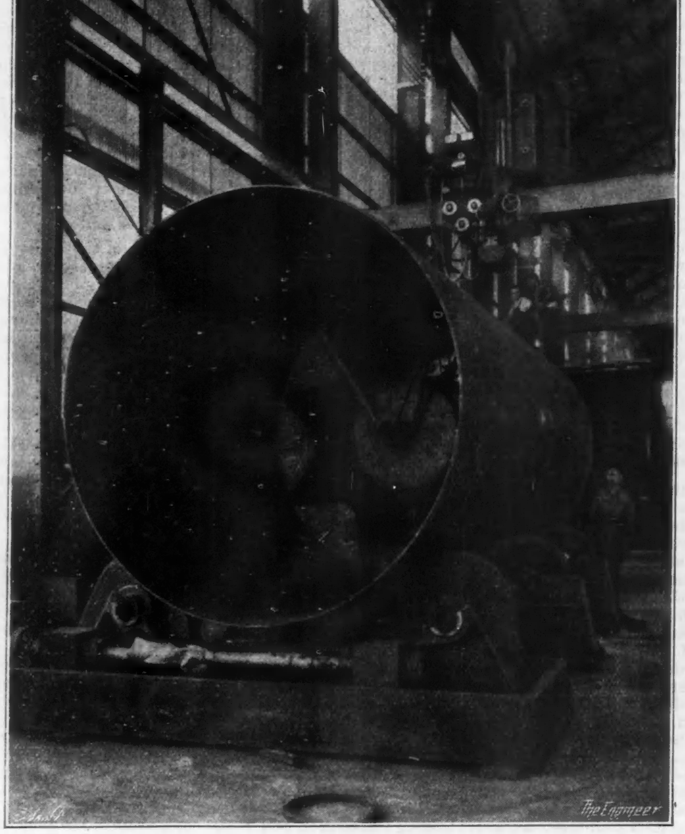

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Fig. 9—Welding Two Pipe Sections Together

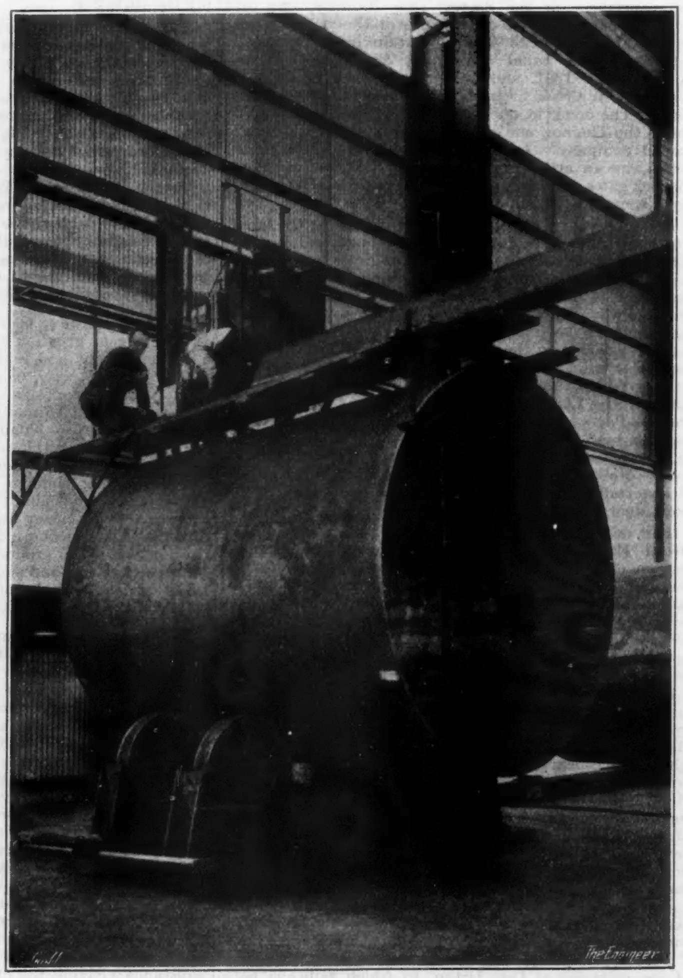
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Fig. 10—Welding a Longitudinal Seam

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NOTICES TO READERS.

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THE USE OF FLYING.

WE discussed a few weeks ago Sir Josiah Stamp's challenging address to the British Association at its Leicester meeting. In the course of his survey of the problem he had set himself, whether scientific advance must ever prove a stumbling-block to economic progress, he did not have much to say about the results of the invention of flying, though he did suggest a doubt whether the debit side of the account has not got a good deal ahead of the credit. The same doubt was expressed by Lord Trenchard, when Chief of the Air Staff many years ago, in bluntly stating—an alarming suggestion at first sight—that if he had his own way he would "abolish the air." In view of these statements, it is useful to see how the "air" entry in the ledger really stands. Many people, including, it seems, Sir Josiah Stamp, at once put all armaments on the debit side; this is hardly fair, but it is in a sense natural, for what it really means is that the technique of attack is at present much more facile than the technique of defence. But, even so, it does ignore the generally admitted, and undoubtedly real, economy both in life and treasure of using the air arm for police purposes in undeveloped countries, especially when these are difficult of access by surface routes.

However that may be, let us see what can, with confidence, be set to the credit side. The first item which everyone would enter is civil air transportation. Here is a fairly comfortable, and not too risky means of very rapid travel, which is of especial value when the surface conditions are interrupted by river, sea, or lake. For long journeys over land in competition with railways, the advantages are less marked, and until night flying becomes common they are likely so to remain. But for a type of journey, such as that from London to Paris, the air route is the pleasanter to most people, as well as being much more rapid. With civil air transport must be included, of course, the air mail services. Almost equally well known, though less developed, is air survey. Few people realise how many supposedly civilised countries are most inadequately surveyed. There is great room for development here, and the air method is well worth support, whether for topographical or cadastral purposes. The taking of stereoscopic photographs from the air enables contours to be plotted, and as an indication of the accuracy attainable, the Air Survey Committee of the War Office has published such a contoured map printed on transparent paper and having the Ordnance Survey for the same area printed on the other side; comparison of the two is most comforting to both methods. It is not suggested that either the one or the other must necessarily be the best method to adopt, each must be judged in relation to the accessibility of the country and the estimated cost of the work. But we may here point out that the air method is still young, and that great advances have recently been made in both speed and accuracy by the use of gyroscopic control for stabilising the surveying aircraft and its camera. For the survey of the lake country of Canada the air method is unrivalled. For forestry surveys and for archæological exploration it is equally good, and it is being seriously used for mining surveys. For military surveys in time of war it is essential, but as that use relates to armament, one must presumably put it down on the other side of the ledger. Canadian experience has also shown the use of the aeroplane for fire patrol and even for fire fighting—a form of fighting which does go down on the credit side, as must also American and Russian experience on crop dusting with insecticide. Mining is not only assisted by aeroplanes used for survey, but by actual transportation of mining machinery. The mines in the heart of New Guinea are so dependent on aircraft that not merely is all the *personnel* so carried, but the heavy machinery itself, despite its weight of many tons. The most recent development is the use of aeroplanes to combat the terrible scourge of locusts. Here is an attack on a real air enemy, which fortunately, if it succeeds, will go down among the greatest of assets. Locusts, when in the hopper stage—that is, before they have grown their wings—are customarily attacked on the ground by the use of poison bait. There are other ways, but that is the best. Damp molasses and sawdust, with a sprinkling of arsenic, is, oddly enough, a mixture enjoyed by locusts, but the meal is fatal; the succeeding ranks of the moving host feed on the poisoned bodies of their fellows, and so the good work goes on. But sometimes the terrain is unsuited to this method, and always countless millions escape the attack and grow to flying estate. To deal with these has so far proved an insoluble problem, but the experiment of attacking them from the air is now to be undertaken. The staff work is in the hands of the Locust Control Committee of the Economic Advisory Council, and preparations are well on the way. A very finely divided poison dust will be used, and it will be scattered in so thin a cloud as to avoid the risk of danger to ground dwellers. But, thin as the cloud is, it appears from laboratory experiments made on batches of locusts flown home from East Africa by Imperial Airways, and on some bred for the purpose in this country, that the enemy is conveniently sensitive to it. Death is expected to ensue to any locust which flies through this cloud. All that has to be done, therefore, is to lay a suitable cloud trail across and ahead of an approaching swarm. It was first intended to carry out the test among the huge swarms infesting Kenya, but whether because the plan became known to the locusts or for some other reason—the right one has not been ascertained—practically all the swarms committed mass suicide before the experiment could begin! So it will have to start in the regions further south among the "red locusts," which, it is to be hoped, will prove less temperamental than their "tropical migratory" brethren of Kenya.

The issue, in every sense of this latest experiment, is still "in the air," but great hopes are being built on it. If it succeeds, it may well indicate a means of saving millions of pounds' worth of crops in ensuing years. The idea is a fascinating one, as it opens up the alluring prospect of a kind of three-dimensional disinfection against plagues and diseases of many sorts. Surface transport operates in two dimensions, air transport in three, and the consequences of that additional freedom have yet to be fully worked out. When they are we may all be greatly comforted by benefits to the human race which will amply merit entry on the right side of the ledger.

Professional Ethics.

THE address which Mr. A. C. Dean delivered on Wednesday, October 11th, to the Manchester and District Association of the Institution of Civil Engineers, as chairman of the Association, drew attention to some matters in connection with the professional conduct of consulting engineers which are of more than local interest. His remarks afford an opportunity for comment on that code of professional ethics, written and unwritten, which is supposed to govern the relations of consultants to their clients and to their fellow-members of the engineering profession. It is with the comparatively limited number of those who practise as consulting engineers, using that term in the sense generally understood in this country, that Mr. Dean is concerned, and not with the "host of non-professional engineers with high-sounding titles, appendages, and pretensions" which has grown up in recent years. He recalled that "a few years ago an American paper collected some 300 titles by which these pseudo-engineers had described themselves in that country, among whom were such unusual branches of our profession as publicity engineers, income engineers, clothes engineers (obviously entitled to the old appendage 'C.E.'), completing the list with 'the exterminating engineer.'" Almost every professional society provides in some form a code of conduct for the guidance of its members, such codes in general being chiefly for the purpose of determining rules of professional practice, the observance of which should tend to the maintenance of amicable relations between its members and just dealing between them and contractors and clients. The by-laws of the Institution of Civil Engineers contain, as Mr. Dean pointed out, rules laid down for professional conduct which are perhaps purposely limited to cover only relations with the public. There is nothing in these by-laws which directly governs the general conduct of the civil engineer towards his colleagues. The rules of professional conduct of the Association of Consulting Engineers, which are designed for the guidance of those whose work is of a purely consultative character, go much further than the by-laws of the Institution and form a sound code of ethics and useful rules of professional practice. Mr. Dean quoted the words of Dr. Tudsbery, on the occasion of the meeting in 1918, commemorating the founding of the Institution of Civil Engineers, in reference to the rules of the Institution as to professional conduct. Their general purport, said the then secretary of the Institution, "is to ensure that the engineer's utmost skill shall be placed at the disposal of those who employ him, and that the method of his remuneration shall not involve any conflict between his personal interests and those of the client whom he advises." This, Mr. Dean observed, may be paraphrased "as 'seeing that the client gets his money's worth,' and it is not enough. The fiercer competition of recent years may have tended actually to make many of the purely ethical rules honoured more in the breach than in the observance, but the principles of honesty and fair dealing should be within the conscience of every man."

Important matters of actual practice discussed by Mr. Dean in his address are those of the relations between architects and engineers, and between engineers or architects and designing firms of a commercial character. Modern building methods make the joint operations of engineer and architect imperative, and there must often be overlapping in their respective spheres of work to such an extent as to make it almost impossible to draw the line between their responsibilities. A difficulty which has occurred from time to time in this respect has been in regard to the allocation of fees. The mutual relations of architects and engineers in these matters should be capable of adjustment, and we believe that negotiations between representatives of the two professions with this object have been and still are in progress. But another difficulty of even greater importance has arisen in recent years. A client arranges a fee with his engineer or architect, and it is therefore only human nature that the engineer or the architect, who is not usually lavishly rewarded for his work, whatever it may be, should want to get as much of the fees available as is legitimately and ethically possible. The practice has therefore sprung up of obtaining the apparently gratuitous assistance of specialist designing or manufacturing firms in providing designs for the engineer or architect in cases where he is not competent to do the work himself. Of course, such services are not in any true sense gratuitous, and the cost of them is in many cases met in some manner that is not overt to the clients. In such cases the effect is that the client pays twice for his engineering or architectural services, and the matter therefore may be one of unprofessional conduct. The Ministry of Health has in recent years done something to minimise this undoubted abuse in the case of public works and building operations carried out by local authorities under its control. Another matter which bristles with difficulties, and on which professional opinion is much divided, is that of the permissible limits of advertisement, direct or indirect, in the case of consulting engineers. It was, said Mr. Dean, "an essential requirement of the old code of conduct that the client should seek the engineer while the latter remained quietly waiting in his office. We know perfectly well that this is rarely the case in fact. It is illegitimate in theory for consulting engineers to compete in any way for work, but if they are to obtain engagements they must achieve the same result by indirect methods. It is frequently the case that the only measure available to this end is some form or other of self-laudation." Too frequently an engineer struggles to bring his name before the public, principally through the medium of the Press, in various ways which are considered legitimate; and it must be said that to the unprejudiced onlooker these operations occasionally appear somewhat ridiculous. It is, said Mr. Dean, "inevitable that the engineer must practise some form of advertisement and come out into the market to sell his wares in the form of his technical skill. There are far more professional engineers than there used to be, while the public has no means, unless through occasional personal knowledge, of knowing . . . what engineers are available to help them, and what are their experience and ability." As he sees it, there is to-day, for good or ill, a tendency for the profession of engineering to move more and more towards a purely commercial basis, and the profession of architecture is probably developing on similar lines. The young architect is able to bring his name before the public through the medium of competitions, but this is not usually a course open to the engineer. A growing practice, which has nothing to commend it and combines self-advertisement with the transference of professional labour and duty from the person who ought to be responsible to another party whose payment is frequently indirect, "is the practice whereby an engineer or architect employed by a public authority or commercial undertaking claims credit as the designer of a particular structure, whereas in actual fact the whole scheme has been worked out by competitive commercial interests who, directly or indirectly, have received remuneration for their work. Such an engineer or architect usually 'gets away with it' by stating that the details were prepared by Messrs. ———." In Mr. Dean's view this is "cheap and unworthy even if the present elastic limits of professional rules are not actually exceeded." It has often been suggested, in the course of the last few years, that corporate advertising on behalf of and controlled by some professional engineering body might be advantageous to consulting engineers generally, and would avoid all the objectionable features which are inherent in personal advertisement, direct or indirect. Mr. Dean, in his address, said that "corporate advertising on a very modest scale has already been carried out by some professional bodies, and it must be admitted that it is very doubtful whether the public in general has been affected one way or the other."

It is not too much to say that Mr. Dean's address crystallises ideas and aspirations which have been present in the minds of many consulting engineers for some time past. There are obvious difficulties which confront the Council of the Institution of Civil Engineers, and, to a lesser extent, the governing bodies of the other great professional institutions, in extending rules of professional conduct and in enforcing such rules in practice. The Association of Consulting Engineers has done something in this direction, and its influence is not confined only to the members of the Association, but extends over a wider field. Nevertheless, the present conditions cannot be regarded as satisfactory. The Institution of Civil Engineers and the other institutions seem to be powerless to deal with abuses in practice which, we fear, are increasing both in magnitude and in variety. One suggestion which, in our opinion, is well worth consideration as a means whereby the control of the professional conduct of consulting engineers could be strengthened and extended, is that the Institution of Civil Engineers should enlarge the functions and strengthen the powers of its professional conduct committee to enable the latter to co-operate in furthering the work now being done by the Association of Consulting Engineers. Alternatively, it might be possible to delegate to the existing Engineering Joint Council the powers possessed by its constituent institutions of formulating rules of professional conduct, and the duty of advising the councils of the respective institutions in matters of discipline relating to those of their members who are engaged in consulting practice. Neither of these suggestions was made by Mr. Dean in the course of his address, but it seems to us that one or other of them offers, at any rate, a possible and practicable method of dealing with the unsatisfactory and somewhat chaotic condition of affairs, as, for instance, in regard to the vexed system of advertising, which now exists in the profession.

Fuel and Man.[*]

By Sir WILLIAM J. LARKE, K.B.E.

[The address opens with a very attractive survey of the history of fuels and their use by man, and continues as follows.]

We are now in a position to take a general survey of the enormous increase in the utilisation of mechanical energy which has resulted from the progressive developments which have been all too briefly sketched. It is calculated that the average man requires, for the maintenance of his physical well-being, between 3000 and 4000 calories per day—less than one-tenth of a therm, or, say, about 25 therms per annum. Since the thermal efficiency of the human body cannot be assumed to be greater than 25 per cent., we can imagine the limitations under which mankind constructed some of the great structures of ancient times, requiring as they did the expenditure of considerable physical energy to place the materials in position.

The increase in productivity and control of the resources of Nature, with which the mechanical extension of his powers has provided man, cannot be better expressed than by an approximate estimate of the heat and power consumption (reduced to therms), per head of population, of the principal industrial countries. The six countries having the highest total heat energy consumption, including coal, oil, and water power, are given in the following table :—

Consumption per Head of Population in 1929 (*Therms*).

Country.	Population, millions.	Coal.	Petroleum.	Water.	Total.
Canada	9·00	1406	252	75	1733
U.S.A.	106·00	1006	515	10	1531
Belgium and Luxemburg	7·87	1465	20	—	1485
United Kingdom	44·50	1196	46	—	1242
Germany..	63·00	1216	18	2	1236
France	40·00	699	31	5	735

The heat energy per head of population, it will be noted, varies from 2 therms per head per day in France to 4½ therms per head per day in Canada—say from 30 to 70 times as much as before the mechanical era.

The wide discrepancy in heat consumption per head in different countries is of considerable interest, particularly as the six countries in question enjoy a very similar, and indeed practically equal, standard of material culture and in the widest sense of industrial development.

In Canada the high consumption is no doubt largely due to the severe winter and the consequent high consumption of fuel for domestic purposes, and also to the very high proportion of fuel per head of the population utilised for transport purposes, owing to the long distances separating the different communities, which necessitate a very extensive railway system, there being nearly 50,000 miles of railway for a population of 9,000,000 people. In the United States, which has the next highest consumption per head, this is doubtless due to the highly developed railway system, the high domestic fuel consumption in the Northern States, and the high density of motor cars to population as indicated by the particularly high oil consumption. With regard to the development of the motor car, it will be noted that the consumption of oil is twice as high in the United States as in Canada, which has the next highest consumption. Although this disparity is not entirely due to the motor car, it is no doubt the dominant factor.

In Belgium the relatively high consumption per head, even as compared with the United Kingdom, is due to the highly industrialised character of the country, and the consequent large proportion of the population engaged in fuel-consuming industries. The United Kingdom and Germany are more or less directly comparable in conditions and fuel consumption. In France, the relatively low consumption is due to the fact that France is still mainly an agricultural country, in spite of the very highly developed industrial areas of Lorraine and the northern provinces.

The maximum industrial development of the future may be expected from those countries which, while having large agricultural areas, also enjoy considerable natural resources of potential mechanical power in the form of coal, oil, or water. Not only do such resources permit the growth of local industries to meet the needs of their own population, but they provide the means of development of transport of the agricultural produce of the country throughout a widely scattered community, and, in countries like Canada, which produce an annual surplus of such produce, a means of exporting it to industrial countries which are not self-supporting in foodstuffs.

Although water power as a source of energy is of very great importance in certain countries where natural conditions favour its development, as in Canada, and in certain parts of India, it is not an important factor at present in relation to the world production of power. In 1932 water power was only responsible for some 3 per cent. of the total world power production. Oil was responsible for 19 per cent., and coal and lignite for the balance—some 78 per cent.

It is true to say, therefore, that "Coal is still King." It must be admitted that oil has been used with great success under present world conditions for steam raising and the production of mechanical energy by direct combustion, even in competition with coal. Nevertheless, despite the substantial inroads that it has made into some markets previously served by coal, it seems unlikely ever to replace coal or its derivatives as the important fuel on which our modern civilisation is based.

In June, 1933, according to Lloyd's Register of Shipping, out of 66,500,000 tons of mechanically propelled shipping in the world, 56,500,000 tons was steam and 10,000,000 tons oil. It would seem that the development of the modern turbine, high steam pressures and superheat will give a definite advantage to steam so long as oil must be used in engines of the reciprocating type. While this does not preclude the use of oil instead of coal for steam raising on such ships, this would be a question of the relative availability of oil and coal, particularly as regards price. This would be largely conditioned by the demand for oil and its derivatives in internal combustion engines on the one hand, and the cost of transport and refuelling stations on the other.

The advantages of oil firing for boilers are undoubtedly great, but principally of a character where they will find their greatest advantage in warships and liners, leaving the greater proportion of the steam-propelled tonnage of the world to use coal, with possibly equal advantage to oil, all things considered. Such a general statement is obviously open to controversy, but it is probably sufficiently accurate to indicate the general trend of coal consumption for marine purposes in the near future.

From 1905 to 1930 the world production of coal and lignite increased from 900,000,000 tons to approximately 1,400,000,000 tons, whereas oil production during the same period increased from 27,000,000 tons to nearly 200,000,000 tons. Thus, the rate of increase in oil, as would be expected from the development of the internal combustion engine both in motor cars and for power purposes, is very much greater during that period. It must be borne in mind that up to recent times coal or its derivatives could not have provided an alternative fuel for the motor car in its present form, so that this consumption is not provided from oil at the expense of coal, whatever may be the case in the future as a result of the development of the hydrogenation of coal, the use of pulverised coal, and particularly the use of compressed gas.

A new development from America is the introduction of butane, which can be compressed to a liquid form at a comparatively high temperature. This is finding a large market for the provision of heat and light in isolated districts. The boiling point of butane at atmospheric pressure is 14 deg. Cent., and it has a very high calorific value. This, however, is at present derived from natural gas, and is therefore dependent on the continued availability of supplies. Experience obtained from this development may result in the use of compressed gas more extensively in the future than in the past, particularly if the economic availability of oil products in relation to coal and its derivatives were to undergo any change that would increase their value.

Efficiency.

What is the effect on fuel industries of increasing efficiency in their utilisation? Since nearly all fuels are at present natural products that cannot be reproduced synthetically from other products, they must be considered as a wasting asset. As early as 1563 a law was passed in Scotland prohibiting the export of coal, as it was thought that the mines were being exhausted too rapidly. The discovery of new resources continually puts forward the probable date of exhaustion, in spite of increasing demand. While this may be true of the world, or even of a country, there are districts and localities in which exhaustion may well have important and serious consequences, involving the transfer of population in the comparatively near future. New centres of population are naturally growing up round the newly developed coalfields and centres of industry, the availability of fuel being the most important factor in this distribution.

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[*] From the Presidential Address to the Institute of Fuel, October 18th, 1933.

In the development of a mechanical age, if there is no conscious effort at conserving wasting assets, such as coal and oil, there is the incentive to economy in their use resulting from the ever-increasing pressure of competition to reduce the cost of industrial products and services. The effect of this increasing economy on the rate of increasing consumption is well brought out in the recent interesting report issued by H.M. Chief Inspector of Mines.

In this report it is pointed out that while the make of gas between 1913 and 1931 has increased in the United Kingdom by nearly 40 per cent., the amount of coal carbonised has only increased by 7 per cent. In the case of the generation of electric power, while the increase in units generated since 1921 is 165 per cent., the amount of coal consumed has only increased by 37 per cent. One of the largest coal-consuming industries is the iron and steel industry, and although the quantity consumed is affected by the depression through which this industry has been passing, it has also been reduced to a considerable extent by the increase in fuel efficiency in that industry, as the coal consumption per ton of pig iron in 1932 was only 36·4 cwt., compared with 40·14 cwt. in 1913.

An important factor in this increase in efficiency, in coal consumption in particular, is the close study of the properties of the different qualities of coal available in the United Kingdom, and the application of the vast amount of knowledge which has been accumulated by the Coal Survey of the United Kingdom. The work of the Fuel Research Board, Imperial Chemical Industries at Billingham, the gas companies and their research organisations, both individual and collective, in the laboratory and by large-scale experiment, have transformed coal in the last twenty years from a raw mineral fuel used wastefully in the raw state, to a source of multifarious invaluable chemical products, providing, in addition, a variety of fuels having much wider application than coal in the raw state, and thus increasing its general availability and, in time, its consumption. It may not be generally realised that there are many hundreds of different varieties of coal, if qualities and sizes are treated as separate varieties, as they should be. Market research in determining the best quality and size for a particular service must also result in increased efficiency in the use of fuel.

There is no doubt that the work of such bodies as the Coal Utilisation Council must ultimately result in giving to the community the maximum service per unit of price, and securing to the coal industry the maximum price per unit of product. This result is being attained by the introduction in the coal industry of methods of mechanical and chemical treatment that can almost be described as manufacturing processes. The actual winning of the coal is only one, if the most important, of the many operations to which it is subjected before it is utilised as fuel. These processes increase the range of service for any particular quality of coal, and thus increase the value of natural resources to the community possessing them. These operations are so varied that in some cases they are actually conducted as separate industries. As apart from sizing, cleaning, and crushing, there is the production of coke with its by-products, which themselves enter into an entirely different range and sphere of consumption; and last, but by no means least, in scientific interest is hydrogenation.

The large-scale research in hydrogenation of coal being undertaken by Imperial Chemical Industries, Ltd., will provide a source of oil fuels for use in a national emergency, even if it does not ultimately prove possible to compete on equal terms with the natural product. But of even greater importance is the development of a technique of large-scale hydrogenation generally applicable to other products which may well have incalculable results in the future.

It is only through a *planned* technological economy that industrial progress under present conditions can be secured. The fuel industries are more fortunate and perhaps more advanced than most industries in having an accurate statistical basis for their production and distribution policy. It is of first importance to the community that industry generally should be conducted on a profitable basis, for an unprofitable industry is detrimental to the well-being of the community in which it is situated.

It is not sufficiently recognised as one of the difficulties of industrial recovery in the post-war period that industrial development such as has been so inadequately traced in this address has concentrated on the volume and efficiency of production on the assumption that distribution would continue to take care of itself. While this was ceasing to be true at the beginning of the present century, the dislocation of credit, and consequently of purchasing power, resulting from the financial problems of the war, in addition to those created by the setting up of new frontiers and new states, each inspired by a natural but intense economic nationalism tending towards self-sufficiency, has produced a condition where production is in excess of the immediate demand.

Science and industry must play their part in studying more intensively the problems of distribution. It may be fairly claimed that the problems of production, on which such a large proportion of scientific, technological, and industrial energy and intellect have been concentrated for the past 150 years, have been solved, though progress must be continuous in the future. Perhaps the greatest incitement to those whose sphere of work lies in the realm of science, technology and industry, is that no sooner is a problem solved or an obstacle passed than the horizon widens, showing still further possibilities with their problems awaiting solution. But in the absence of a revolution comparable to that which was produced by the introduction of steam and mechanical power, the rate of production, even in the distant future, is likely to be slower, if for no other reason than that its utility will be less until the problem of distribution has been solved. It is on this aspect of our modern problems that the best minds must concentrate their attention. It will no longer be sufficient for the scientist and the technologist to announce discoveries, but with the knowledge they possess of the potentialities of such discoveries they will also require to study the application of their achievements to the welfare of mankind.

It is frequently stated that it would appear as if the development of the mechanical era had produced more problems than it had solved, and that man has eaten of the fruit of the tree of knowledge to an extent that will compass his own destruction. Such a view is, I think, unwarranted, in spite of the evidence to the contrary in the abuse of the developments of science and technology during the war years in their application to the destruction of life and material. The mechanical extension of mankind, in producing with reduced effort ever-increasing wealth, has had the effect, to a greater or less extent, almost throughout the population of the world, of raising the standard of life as compared with the standard existing before the Industrial Revolution in the middle of the eighteenth century. What is needed is surely that man shall rather increase his consumption of the fruit of the tree of knowledge, in that he shall learn how to use to better advantage the wealth and power he has learnt to produce.

OIL IN THE WORLD OF FUEL.

On Wednesday evening, October 11th, Sir John Cadman, the Melchett Medallist, lectured to the Institute of Fuel and other technical societies on "The Place of Oil in the World of Fuel." The President of the Institute of Fuel, Sir Hugo Hirst, was in the chair. After a short reference to the easy transport of oil as compared with coal, the lecturer stated that the most striking rivalry between fuel oil and coal was to be found at sea. A large proportion of the world's ocean-going shipping was now propelled by oil. In 1914 statistics of the tonnage of the world's mechanically propelled shipping showed that 96·6 per cent. used coal and 3·4 per cent. oil. To-day the figures were respectively 54·6 per cent. and 45·4 per cent. The latest available figures indicated that motor ships now afloat had a tonnage of over 10,000,000 and represented 15 per cent. of the world's shipping. Oil had, he said, not replaced coal indiscriminately, but had been adopted for those purposes to which it was particularly suited. Sir John rejected the view that oil was solely a competitor of coal and that the advent of oil and the development of oil-consuming mechanisms had brought no advantages to coal. Virtually every part of every motor vehicle constructed in this country represented a consumption of coal. Similarly, the aeroplane had made its demand upon coal; a compression-ignition engine for use abroad was an export of the energy of coal; a farm tractor was a substitution of coal for horses; a motor boat was an additional factor in the demand for coal. The world's annual production of coal was, Sir John pointed out, vastly greater than that of oil, and amounted in 1932 to over 1000 million tons, and the maritime consumption of oil, less than 20 million tons, was small in relation to the world's annual output of coal, and could not of itself alone have been the cause of all the misfortunes which had befallen the British coal industry. In conclusion, Sir John reminded his hearers that the world's reserves of fuel—whether oil or coal—were limited, even though their full extent remained yet unknown. It was therefore to our interest, and to that of posterity, that each fuel should be made to yield the maximum amount of energy which human ingenuity could extract from it.

FRENCH COLLIERY PRACTICE.

At the inaugural meeting of the Congress of Industrial Chemistry, recently held at Lille, Monsieur Champy, managing director of the Mines d'Anzin, gave an interesting account of the progress that has been accomplished in the utilisation of coal at the French collieries. In the Nord, the capacity of coke production is 5,200,000 tons, but in 1932 the quantity produced was only 2,731,000 tons. The products of distillation comprised 103,110 tons of tar, 36,063 tons of sulphate of ammonia, and 22,900 tons of benzol, while 540,000,000 cubic metres of gas of about 4200 calories were available for distribution. All the tar is distilled by one company, which is capable of dealing with 130,000 tons a year. Several processes are employed for the production of synthetic ammonia, the quantity last year being 61,937 tons, transformed principally into sulphates, and several collieries have laid down plants for sulphuric and nitric acids. Only one colliery has undertaken the production of ethylic alcohol, which, moreover, is making little headway, owing to the limited demand. Carbonic oxide in coke oven gases is harmful to the catalytic manufacture of ammonia, and it was therefore necessary to combine it first of all with hydrogen for the production of methylic alcohol, which it was hoped would find increasing employment as a motor fuel. Two collieries produced 528,000 gallons of methylic alcohol in 1932, part of which was transformed into 200 tons of "formol." The colliery companies in the Nord do not contemplate the production of oils by the hydrogenation of coal, on account of the enormous capital involved and the necessity of protection against imported oils. More immediate results are anticipated from the hydrogenation of liquid products which has already reached a semi-industrial stage. Rather than attempt the hydrogenation of coal, the companies mining bituminous coals prefer low-temperature carbonisation in order to obtain a more porous coke suitable for domestic heating and a gas of higher heat value, together with a richer tar. Two companies have laid down plants which will produce yearly 200,000 tons of semi-coke, 17,000 tons of tar, 475,000 gallons of spirit, and about 20,000,000 cubic metres of gas of 6000 calories. The development of the chemical side of the colliery industry will depend upon the demand for semi-coke, which is, incidentally, being advocated in France as a substitute for anthracite for domestic heating. The association of industrial chemistry with coal mining is also an outcome of the increasing tendency of colliery companies to develop their power generating stations which are necessary for the utilisation of unsaleable coal, and having thus available a considerable surplus supply of electrical energy, the companies have embarked upon the electro-chemical industry, and in 1932 produced 15,393 tons of calcium carbide, 9481 tons of cyanamide, and 771 tons of electrolytic copper.

Literature.

SHORT NOTICES.

The Principles of Electric Arc Welding, Metallic Arc Processes. By R. C. Stockton. London: Sir Isaac Pitman and Sons, Ltd. Price 7s. 6d.—Although much has been written on electric welding, those who have not yet familiarised themselves with the subject, and perhaps even some who are already engaged on welding work, may welcome this new volume. It is based on lectures delivered by the author at the Manchester College of Technology; but, where considered necessary, additional matter has been introduced. Although the major part of the book is devoted to arc welding, spot, butt, and resistance seam welding are considered. Other matters briefly covered are sherardising, electro-plating, galvanising, white-metalling, cast iron, oxy-acetylene welding, and thermit welding. A section is devoted to the principles of manufacture of iron and steel, and the heat treatment of high iron content alloys is discussed. A lengthy chapter covers arc welding in its various aspects and is followed by another on examples of welding practice in which illustrations of real practical value are to be found. Another equally practical chapter is devoted to the testing of welded work and welding materials. Finally, there is a chapter on electrical notes, which serves to familiarise non-electrical people with welding plant and with electrical terms. Of the many books we have seen on electric welding this is one of the most useful from the point of view of those engaged in workshops.

Advanced Electrical Measurements. By W. R. Smythe and W. C. Michels. London: Chapman and Hall, Ltd., Price 15s.—During their experience as teachers of electrical engineering, physics, and chemistry at the California Institute of Technology, the authors of this volume have been unable to find a text-book containing all the material deemed to be essential for the purpose of training electrical students in the use of electrical measuring instruments, and they have, therefore, produced a book of their own. To keep it within reasonable limits, where there are several alternative methods of measuring or comparing the same quantities, the one which has been found to be most satisfactory is fully considered, whilst the others are only referred to. Standard material to be found in most books on electrical measurements, with, perhaps, rather more than usual emphasis on electrometers and the recent types of amplifying valves, is to be found in the first eight chapters, whilst the remaining four are devoted to the application of electrical methods to the measurement of quantities which are not primarily electrical in nature. Because of their ever-increasing application in physical and engineering laboratories, temperature and radiation measurements are considered in considerable detail, and an endeavour has been made throughout the volume to make instructions sufficiently clear to enable students to become versed in the subject of electrical measurements without the help of an instructor. An effort has also been made, wherever possible, to discuss theory before giving actual experimental directions to enable the student to understand the apparatus he uses.

BOOKS RECEIVED.

The Running and Maintenance of Marine Machinery. London: The Institute of Marine Engineers, 85/88, The Minories, E.C.3. Price 5s. net.

Automotive Construction and Operation. Second edition. By J. C. Wright and F. Smith. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 21s. 6d. net.

The Position of British Engineering Industries.[*]

By WILLIAM REAVELL, President, B.E.A.

When I had the honour of addressing you two years ago, at the conclusion of my first year of office as your President, I presented to you some reflections on the great amount of time which had to be devoted by the heads of engineering undertakings to financial and cognate matters which had to be dealt with, and which were quite remote from that kind of engineering which lies nearest to the hearts of most of us, namely, the designing of our different mechanisms so as to obtain the highest efficiency with the greatest economy in weight, the development of our experimental work, and similar matters, so as to keep our products in the forefront in the face of international competition.

The intervening period has been fraught with many difficulties, and it occurred to me that some reflections on these and their bearing on the position as it is viewed to-day by the head of an engineering concern would be acceptable to you.

Two years ago, England had just left the gold standard, and had carried the population with it in the formation of a National Government. Its actions in the two intervening years have, on the whole, interpreted the will of the nation, and although the progress has been slower than many armchair critics would like, because it has been governed so much by circumstances and conditions outside our own country, we have seen considerable changes effected which it is difficult to believe could have been carried out under any system of Party Government.

The confused condition of the world, which, two years ago, we so much deplored, cannot be said to have clarified itself in the intervening period. On the other hand, we find a still more uncertain, and, indeed, threatening, political position in Central Europe, while the circumstances which led to frozen credit in so many countries have not yet found those milder conditions which would exercise a thawing influence for the benefit of those engineers who are still suffering from the lock-up of their capital abroad, or who are desirous of extending their commercial tentacles in those territories. Indeed, in the economic sphere matters have been rendered still more difficult by the action of America, who, on the eve of the World Economic Conference, left the gold standard deliberately, and not by the force of external circumstances, as in the case of our own country. We are all of us watching with intense interest, and, indeed, with some dubiety, the consequent steps which are being taken in that country, with the object of making debts tolerable and industry profitable, regardless of the effect her actions may have on the world outside. To put it bluntly, the United States of America, by that action, probably did more to make the World Economic Conference abortive than any other single circumstance. When the Conference actually met, we, therefore, had the position that France and other gold countries were determined to remain anchored to gold, because of their earlier experience of the consequences of severe inflation, while, on the other hand, America was pursuing a policy of reflation. Probably all of us agree that our own National Government acted wisely in evading the issue between these two methods and deciding not to embrace either of them. It practically meant that those in charge of Great Britain's policy preferred that this country should retain its freedom of action. It does seem, under the present conditions, that a variable pound forms a flexible and automatically adjustable factor in an otherwise rigid system, and has performed a function of the greatest economic value.

In the present unsettled state of affairs, it is very difficult for the ordinary engineer to forecast in any way what the world results will be, but, at all events, we can say that our present financial policy has assisted in what we hope will be the starting of a trade cycle on its upward trend. Our credit in the world remains second to none, and, as a well-known economist happily put it a little while ago, " we remain on the gold standard as regards our character and credit."

The industrial position in our own country seems now to be definitely improving, although, for the reasons referred to, export conditions still remain very difficult and are aggravated by the extreme spirit of economic nationalism, which is so rampant. If, instead of this, we could see the dawning of an era of sane international co-operation, the effect upon world economy would be immediate and emphatic, and the British engineer—who, throughout these troublous times, has never ceased in the development and improvement of his machines—would begin to come into his own again.

Tariffs.

These reflections would not be complete without some reference to the difficult question of tariffs. While we doubtless still agree that the machinery adopted —by means of which our own tariff problems are dealt with by an independent advisory Committee, which can consult with each trade in turn—is wise, we engineers are disposed to deplore recent movements by which trade agreements have been effected with certain foreign countries, apparently without bringing this machinery into full play and without a proper consultation with the trades affected, which undoubtedly include our own engineering trade.

In regard to the importation of certain manufactured articles duty free, one has doubts whether the method at present adopted can have the effect of encouraging British firms to undertake the manufacture of types of machinery not yet made in this country, since they have not the protection which the imposition of a suitable duty would afford.

Let us study the position as it occurs to any one of us who sees the free importation of any machine or apparatus which is in line with the class of machinery he makes, and which he is confident he could satisfactorily produce.

To do so, involves a period of study and investigation, followed by careful design to ensure that the highest efficiency shall be maintained and that it can be produced on the most economical basis. This done, he has now to expend considerable sums in manufacturing the machine in the various sizes required, and in advertising and other ways of making his machines known.

During this period, the machine is being imported duty free, and he must introduce his machine against this price handicap, probably coupled with the fact that the imported machine is made under lower labour conditions than those obtaining here. Even then, until his machine is well known, he cannot hope to be assisted by the imposition of a duty on the imported article.

Is it to be wondered at that under these conditions the British manufacturer hesitates to incur the large financial risk involved ?

Admittedly, if the foreign machine had to pay the duty imposed on that class of machine, the home purchaser would have to pay more for it, but he does so now on other articles which are subject to duty, and if the present principle were altered it would be a great encouragement to our engineering trade to undertake the manufacture of new machines under the protection afforded, and it would also lead to the employment of more skilled and unskilled labour.

I cannot leave this part of the question without pointing out how effective and useful the efforts of the B.E.A. have been in staying the free importation of such machinery in cases where the Association has been able to prove that suitable machines for the purpose could, as a matter of fact, be provided by its members or by other firms, who, though not yet supporting the B.E.A., have benefited directly by its action.

In addition to the question of whether the present tariffs afford adequate protection to British manufacturers, so as to encourage them in further developments which would employ more labour, there is undoubtedly a menace with which it is difficult to deal, even by high tariffs, namely, the flooding of our markets by the productions of certain countries, particularly in the East, who pay extremely low rates for labour. It is sometimes accompanied by definite attempts to evade the mark of " Foreign manufacture," as in a case cited at a recent conference by a representative of the pottery trade, who gave an illustration of the importation of Japanese cups and saucers, sold in England at 3d. per cup and saucer. These were stamped " Mode in England," which was clearly an attempt to lead purchasers to think that the articles were actually made in this country. The real trouble here, of course, is that the articles are made by labour paid at such an extremely low rate that little short of prohibition will assist the British manufacturer.

Low Wage Competition.

Up to the present, we engineers have been largely immune from this low-waged competition, but from a recent publication of the F.B.I., entitled " The Menace of Japanese Competition," we are now threatened with it. It publishes a letter which is being circulated in foreign markets by agents of Japanese exporters, in which they explain why they are concentrating on the export of Japanese machinery and ask for first-class firms to correspond with them. The list of machinery they offer is as follows :—

Wool, cotton, silk spinning and weaving plants, dyeing, bleaching, printing and finishing machinery, humidifiers, air blowers, air compressors, ice-making machinery, steam boilers, steam turbines, generators, motors, Diesel and oil engines, locomotives, road rollers, conveyors, water pumps, chain blocks, electric hoists, ball bearings, machine tools, leather and rubber belts, &c.

With regard to our trade relations with our own Dominions, and the problems which are raised by the various tariffs they impose, it is difficult for the British manufacturer, even if he has visited some or all of the Dominions, to put himself in their place and understand these tariffs from their point of view.

We most of us have experienced the difficulty, for example, of exporting to Australia, having in mind the high tariffs which that Dominion imposes, though we are all familiar with the serious financial difficulties from which she has suffered. It is therefore gratifying to us all to read, as we have recently done, of the greatly improved position disclosed by the Australian Prime Minister's Budget speech, and we are glad to note that the tariff question is under review.

As far as one can gather, the modifications refer to the question of primage,[†] and the compensation which they give themselves on account of the fall of the Australian pound compared with sterling, which we may refer to broadly as difference in exchange. The exact advantage to the British engineer will not be clear until further details reach us, but it is hoped that they will be found to alleviate some of our difficulties in endeavouring to export our machinery to them, and that their improved financial results will enable them to increase their purchases from us.

Frozen Credits.

The financing of orders from foreign countries still causes us grave concern, and what we know as " frozen credits " greatly discourage us in attempting to export to certain foreign countries, on account of the difficulty in getting payments transferred to us.

As an example of the kind of thing a British engineering firm has to contend with in conducting its export trade, I may cite a case in which certain machinery was exported to a South American country as stock for future sale by the manufacturer's own sales organisation on the spot, and was soon rendered unsaleable in that market by a Government prohibition of the importation of certain raw materials essential for the use of the machinery. The British exporting manufacturer thereupon took steps to re-export his machinery for sale in other markets, but was stopped by a Government prohibition which made such exportation conditional upon the exporter guaranteeing to return into the country the equivalent value in foreign money or goods. In other words, he was prevented from recovering possession of his own property in respect of which no payment had been made by anybody in the country to which they had been exported.

There is no doubt that several of my hearers could supply, from their own experience, similar examples of the difficulties we come across in endeavouring to increase our exports.

Trade Improvement and Employment.

I have referred to the signs of an improvement in trade, and it is gratifying to note that this is evident in our basic trades, when tested either from the standpoint of output or of the reduction in unemployment. This is, happily, true for iron and steel, coal, and different branches of engineering, and even for that important industry of shipbuilding, which has so long suffered from the absence of orders and from the pernicious effects of subsidisation by foreign countries.

It is a painful reflection, however, that the financial results up to the end of last year, as disclosed by the figures published in our September *Bulletin*, show that the earned profits of fifty-seven representative engineering and allied firms, representing a total of paid-up capital of £127,000,000, fell to the unprecedentedly low figure of 1·1 per cent., and that although the average amount distributed in dividends was 2·8 per cent. of the paid-up capital, it was equivalent to more than two and a-half times the earned profit. It is obvious that this must have involved a serious draft on already depleted reserve, which in some cases must now be approaching exhaustion. It is to be hoped that when the figures for 1933 are available they will disclose a more satisfactory and sane result.

One avenue of development on which much has been written is that of our expenditure on public works, and while we undoubtedly agreed with the National Government's condemnation of sporadic expenditure on roads and similar objects at the time, thoughtful men are now inquiring whether there is not a case for a more detailed examination of the matter from the point of view of encouraging certain works which might be proceeded with by municipalities, where the expenditure would directly assist our basic industries of iron and steel, coal, and engineering.

Objects which suggest themselves are the local electrification of railways, as opposed to the more ambitious problem of main line electrification ; or a re-study of the problem of water supply, which is now being examined by a committee of the Institution of Mechanical Engineers—not, indeed, on so bold a basis as a water grid, but an examination from the point of view of numbers of local centres where a central water supply could be extended to serve large adjacent areas, to the advantage of the population, as this summer has shown, and with an extension of employment in our engineering industry and the basic trades.

The same observations would appear to apply to extensions of the gas supply under pressure in outlying areas by municipalities and gas companies. If some encouragement were given to the suppliers of gas, as the Government has done in the case of electrical undertakings under the grid scheme, but limited to a wide enlargement of their powers of supply in local areas, it would probably be found to be of national advantage and would undoubtedly help engineering and the basic trades.

Cut-throat Competition.

This leads me to another reflection, based on experience, with which I am sure you will concur, namely, that there is too much cut-throat competition. There are too many unhappy illustrations of taking orders at a loss, and this financial folly must, in the long run, be disastrous. It leads one to express the hope that the B.E.A., with the growth of the group system, can take steps by consultation and wise organisation to bring about a state of things where a fair price is paid for honest design, high efficiency, and good workmanship. The B.E.A., supported, as it should be, by the whole engineering trade in this country, could do much to bring about such a change, to the advantage of employers and employed alike.

Conditions of Contract.

There is another matter which directly affects us all, and that is the unduly onerous and unfair conditions of contract and unsatisfactory terms of payment which we so often find in specifications submitted to us.

One illustration which recently came before me deals with the vexed question of consequential damage. The specification reads :—

> " The contractors undertake to indemnify the purchasers against all damages, expenses and losses which may result as a consequence of partial or complete non-compliance with the clauses of this schedule of conditions, or of bad workmanship or bad quality of materials used . . . "

Another, which illustrates the extreme powers the engineer demanded in regard to materials, says :—

> " The engineer, if he thinks fit, shall send a representative to inspect the manufacture at any stage, and the contractor must send the engineer two copies of the orders for the material sublet.
>
> " The engineer shall have power to take independent tests of the material, to be carried out by some person appointed by him at such place as he may determine, and from the results of such tests there shall be no appeal."

The absence of any provision for a fair arbitration clause is also still too common. Surely the day has gone past, for example, when the chief engineer of any undertaking should arrogate to himself the position of being the sole arbiter of the circumstances when deductions shall be made or penalties applied. Surely it is only reasonable that where penalties are exacted for late delivery, a corresponding bonus should be paid to the manufacturer for earlier delivery.

Here, again, I would like to acknowledge, on behalf of engineers generally, the work which has been done by the B.E.A. in regard to the improvement in contract conditions, and particularly the diligent and persistent efforts which have been made in this direction by Mr. Bremner himself, as Chairman of the Committee of F.B.I., dealing with this important matter.

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[*] Address at the Annual Meeting of the British Engineers' Association, Thursday, October 12th, 1933.

[†] Primage was originally a small charge made by the captain of a vessel for the use of tackle, &c., but in Australia has become an extra duty charged on the c.i.f. price of goods. In July, 1930, it was 2½ per cent., in November of that year 4 per cent., and subsequently it became 10 per cent., when the duty on British machinery was fixed at 45 per cent. It is now to be reduced.

Exhibitions.

One other point of importance to us, and I have done. It relates to exhibitions and fairs. Under the conditions which at present obtain, we frequently find ourselves in a dilemma which forces us to take part in an exhibition because there is no machinery by which we can come together and discuss the wisdom of that action amongst ourselves, and we are therefore driven to the expense of an exhibition simply because "the other fellow is showing." Could not the weight of this Association be thrown into a movement for one really strong engineering exhibition, preferably held every two years, in which all branches of engineering endeavour to combine so as to show, at reasonably recurring periods, the best that England produces ?

The B.E.A.

Regarding our own Association, there have been growing evidences during this year of the excellent work which has been done ; work which often redounds to the advantage of engineering firms who are not assisting in the cost of running our organisation. Take, for example, the question of tariff boards in our Dominions, where our Association is not yet financially strong enough to do what it would wish. I picture the time when we shall be able to maintain our own representatives in Australia and Canada, armed with all the information necessary to enable them to represent fully the wishes of our members in regard to any type of manufacture where we think that, at present, the scales are weighted too heavily against us, and where we are in a position to prove that a modified attitude on the part of the Dominion concerned would be of benefit not only to the British manufacturer, but to the purchaser in that Dominion.

I would again reiterate the hope I have expressed previously that the advent of better times, which we can surely see now, will bring such an influx of members to our Association that we can tackle many other tasks which are still on our programme, and which, up to the present, have been left undone for lack of that strong national support which we deserve.

Industrial Heating Congress.

The problem of securing the greatest economy in oil and coal combustion and of making the most of poor fuels is regarded as of the highest importance on the Continent, where the economic future of countries possessing limited supplies of fuel, often of inferior quality, is believed to depend upon its solution. So vast is the range of questions involved in this discussion that no fewer than 150 papers were presented at the third International Congress on Industrial Heating, which was held in the Conservatoire des Arts et Métiers in Paris last week. The inaugural meeting was presided over by Monsieur Walckenaer, in the presence of Monsieur Henry de Chatelier, Monsieur Charpy, and other distinguished scientists and metallurgists.

A matter that received immediate attention was the utilisation of low-grade coal at some of the Continental collieries, notably in the North of France, where the coal is won with a high percentage of slack which must be used profitably if the industry is to be placed on an economical basis. The slack is employed in power stations at the collieries, and it is hoped that a demand will be found for it with burners for ovens and furnaces, while a communication on the successful briquetting of lignite in Germany with a press exerting a pressure of 12 tons per square inch on special moulds suggested the possibility of something being done to make briquettes of small coal without the use of binding material. Semi-carbonisation processes were naturally discussed. Monsieur Charles Berthelot said that experimental work in that direction had cost something like 2000 million francs and that about 2000 types of furnaces had been invented, of which not more than a dozen had given satisfactory results. Nearly all the French collieries are producing semi-coke, but are making little out of the liquid by-products, and the only hope for semi-carbonisation lies in popularising the use of coke for domestic heating which the colliery companies are making great efforts to accomplish in competition with gasworks coke. According to Monsieur Simonovitch the experience in Belgium is that semi-coke produced by low-temperature carbonisation is of excellent quality for domestic heating, but that it must be sold at a low competitive cost, which means that a profitable outlet must be found for the tar. It is a general complaint that only a relatively small proportion of the tar is saleable. There are, said Monsieur Simonovitch, enormous possibilities in low-temperature carbonisation, but he questioned whether distilled oils could compete normally with natural oils.

Amongst the papers on economical combustion that of Mr. David Wilson on the results of the latest developments in steam generation in England was practical and informative, and he concluded by saying that he had reason for believing that a new process, to be applied on a large scale, was likely to prove of great importance from the point of view of economy and would, perhaps, rival pulverised coal. The idea of raising combustion temperatures by the simultaneous use of two different fuels was put forward many years ago, and it is only recently that tests have been carried out methodically with the system, alike for steam raising and in internal combustion engines. One such application was described by Monsieur Joulot, who gave an account of an incineration plant in conjunction with an electrical power installation working on this principle which was put in operation at Bordeaux in February last. Steam for the power plant had to be raised either with a mixture of coke breeze and Welsh coal, or by the incineration of 100 tons of town refuse a day, or by a combination of the two. There are three Babcock and Willcox boilers of 600 square metres heating surface with superheaters and Green economisers, and each has a Babcock and Willcox double mechanical grate and four refuse-burning grates of the Heenan and Froude type constructed by the Société "Union des Services Publics" in Paris. The gases from the refuse grates pass into the combustion chamber above the mechanical grate with an apparently greater density owing to their lower temperature, and the whirling effect obtained ensures a perfect mixture and complete combustion. The efficiency tests of the plant are still in progress.

Examples of what can be done with the economical working of marine engines were given by Monsieur Roger Martin, laboratory director at the Office Central de Chauffe Rationelle, who said that without any modification of boilers their efficiency could be greatly increased by a more careful supervision of working with the aid of temperature and other control instruments. There was no necessity for a costly installation. Only a few essential instruments were required, and a little care on the part of those in charge of the boilers would produce notable results. In one case, a 9000-ton cargo ship with 1500 horse-power engines increased its speed from 8 to 10 knots with the same fuel consumption because control instruments allowed of the boiler being worked to give something like its best efficiency. In a passenger ship with engines of 9000 horse-power the installation of a few control instruments was followed by a reduction of 35 per cent. in fuel consumption. Similar results were recorded in other ships over long periods. The point stressed was that the merchant marine did not attach the same importance to the value of temperature and gas control as is customary in steam-raising practice on land, and yet on cargo ships fuel economy may be, at the present time, the only determining factor in profitable working.

The problem of propelling aircraft by steam was presented in a somewhat novel manner by Monsieur Rabinovitch, who pointed to the possibilities of highly efficient turbines with high steam pressures and temperatures. For high powers the turbine can compare with the petrol engine, with the further advantage of flexibility and of running at great altitudes. The weight of the turbine could be reduced by the use of high resistance steels in the same way as had been done with the petrol engine ; but while there appeared to be no reason why the steam turbine should not be developed in that way, its evolution would probably take as much time as that of the present type of aviation engine. Nevertheless, Monsieur Rabinovitch thought that the matter was worth investigating in the case of passenger-carrying machines. He made no mention of the steam generator and water supply. The aviation engine was also the subject of a communication by Monsieur Clerget, who has been for some years working out the problem of the heavy oil engine for the French Air Ministry. He spoke of experiments he had carried out with the simultaneous injection of two different liquids, which had already given encouraging results and indicated that there is something to be done in this direction. A 2·61 litre engine running at 1900 revolutions per minute developed 14·5 horse-power with gas oil, the consumption being 199 grammes per horse-power and the thermal efficiency 30 per cent. With the same engine a simultaneous injection of 109 grammes of oil and 89 grammes of alcohol gave a thermal efficiency of 39 per cent. Monsieur Clerget thought that the double fuel injection might change completely the characteristics of the present type of compression-ignition engine by giving to it a higher efficiency and flexibility and tending to a reduction of weight comparable with that of the petrol engine. In summing up the discussion on this matter, Monsieur Dumanois, who is a leading authority on internal combustion engine research, and is at the head of State fuel and other technical services, mentioned, incidentally, what had been done in the way of burning pulverised coal in engines. He seemed to imply that it might be worth while to continue experiments with the injection of pulverised coal with some liquid fuel. The introduction of the high-speed compression-ignition engine led Messrs. Boerlage and Broeze, engineers at the Delft laboratory of the Bataasche Petroleum Company, to issue a warning with regard to the future supplies of special oils required for such engines. In the original slow-running type of solid oil injection engine the quality of the ignition, or the timing of it, had no effect upon the working, but with increased speeds this quality has to be taken into account. The higher the speed the greater is the care necessary in the selection of fuels, and as there is available only a limited quantity of the special oils employed for high-speed engines there is a risk of the price going up and even of supplies being monopolised for aviation purposes.

The cost of electricity produced by heat and hydraulic power plants was shown in a diagram prepared by Monsieur Stoeffler, wherein it appears that at about 800 hours of supply per year the cost per kW at the hydro-electric station is 29 centimes, and at the heat power station 22·7 centimes, while at 8000 hours the cost of the hydro-electric production is 4·8 centimes and of the heat power production 7 centimes. The curves coincide at 3355 hours with 9·58 centimes. Heat plants have an advantage in lower capital charges. As the distributing companies do not take current for more than 2500 hours per year, the economy is on the side of heat power stations. Another aspect of the relative situations of heat and hydro-electrical generating stations was given in a communication by Monsieur Dauvergne, who considered them from the point of view of the influence they exert on wages. He concluded that new hydraulic concessions for electrical production should only be granted in cases where current can be supplied at below the price of the heat power station supply so that the benefit accruing to the consumer will compensate for loss in wages. Hydro-electrical plants should be regarded as supplementary to heat electrical generating stations and not be in competition with them.

An unusual heat engine was recently devised by the Westinghouse Electric and Manufacturing Company for exhibition at the Chicago World's Fair. A small bi-metal disc snaps from concave to convex form as its temperature is raised to about 400 deg. Fah., and snaps back to concave shape when it is cooled below 255 deg. Every 10 seconds the "kick" of these snaps tosses the disc, which is fastened to a freely swinging arm, to and fro between a highly heated stove-like cylinder on one side and an ice-cold cylinder on the other. A maximum speed of 2000ft. per second is reached, or about 23 miles a minute.

The Holmes Jubilee.

Among the pioneer electrical firms that began in a very small way and are still in business, that of J. H. Holmes and Co., Ltd., now of Hebburn-on-Tyne, has always held a prominent position. It came into existence as a private concern in 1883, and this year therefore marks its jubilee. With a single workshop and a staff composed of one man and a boy, the initial activities consisted of providing electric light for houses, factories, and steamships. A private plant installed in the house of Mr. W. H. Holmes, the father of the present Mr. J. H. Holmes, gave rise to lengthy articles in the local newspapers, for it was the first house in the Tyneside district to have a permanent supply of electricity. Current was provided by a half horse-power gas engine driving a Siemens dynamo, working in conjunction with a battery. Later, a 25 horse-power plant was installed at Jesmond Towers, Newcastle, the battery being used to motor the dynamos when starting the engine. Before the end of 1883 the firm had completed an arc lamp lighting installation at the Silloth dock works, and had supplied lighting equipment for the "Nonpareil," the first mercantile marine steamship built on the Tyne to have such an equipment. An interesting feature of the side-light fittings was that they were provided with automatic apparatus for bringing new lamps into circuit in the event of old lamps failing.

A special effort was made in 1884 to bring the advantages of electric light to the notice of the public. In January of that year the firm purchased a portable plant, complete with boiler, and made it known by means of circulars that it would undertake the work of providing temporary electric light installations at public gatherings or in private residences. Thus it came about that after a short time no bazaar in the neighbourhood of Newcastle was considered complete or up to date without this new system of lighting. On the occasion of the visit of the Prince and Princess of Wales to Newcastle in 1884, in connection with the opening of Jesmond Dene to the public, this portable plant was used to supply current to an arc lamp in the lantern tower of St. Nicholas's Cathedral.

During the same year the firm began to build its own dynamos and motors. The first machine, completed in 1885, ran in Ireland for about thirty-five years, after which it was exchanged, rather against the owner's wish, for a modern machine in order that the original dynamo might be put in the works' museum. Later, it was transferred to the Newcastle Municipal Museum of Science and Industry. In those early days, dynamo design was more or less a matter of guesswork, but in 1886 a great advance was made by the reading of a paper before the Institution of Civil Engineers by Gisbert Kapp, who showed how the necessary dimensions, number of turns, &c., for a given output could be calculated. The new principles laid down in that paper enabled J. H. Holmes and Co. to begin the manufacture of a new range of dynamos, the first of which was put in hand in May, 1886. Various improved features were introduced, and outputs began to rise until one machine was produced with an armature 17in. in diameter. Its output was 38 kilowatts at 450 r.p.m., and in view of the abnormal dimensions, it was christened "Jumbo." The name "Castle" was registered as the firm's trade mark for dynamos and electrical instruments. Many of the early dynamos were used for lighting picture galleries, theatres, and dining-rooms, and their successful operation at the 1887 Newcastle Exhibition resulted in orders being received from many parts of the country.

The quick break switch, which in much larger sizes and in modified forms now serves for controlling electric circuits under all sorts of conditions, was invented by Mr. J. H. Holmes in 1884. On the occasion of the opening of a new café in Wallsend, Mr. Holmes' attention was directed to the danger of forming an electric arc in a wooden switch-box by breaking the circuit slowly, and in consequence the quick-break switch was devised. Other inventions followed, and the firm's business continued to increase. A new factory was built in 1887, and was subsequently extended.

Whilst in Egypt in 1889 Mr. Holmes gave attention to the requirements of vessels proceeding by night through the Suez Canal. For the benefit of vessels without electric light, he introduced a portable lighting equipment, which was hired out by the coal shipping companies. It consisted of a steam engine coupled to a dynamo and fitted in a cage with a lifting eye, so that it could be slung on to the deck of a vessel and be connected up to the steam supply by means of piping with universal joints. In this way the capacity of the canal was effectively increased.

Electro-plating dynamos, including one designed for an output of 3000 ampères at 5 volts, were among the comparatively early Holmes' machines. During 1897 the firm acquired the patent rights for the "Lundell" electric motor, which had already met with widespread application in America, especially for driving small fans and printing machinery. In the latter field the machine soon met with favour in Great Britain, which had hitherto given little attention to electric motive power. In 1898 the patented Holmes-Clatworthy system of electrically driving newspaper presses was introduced, and the first equipment, which was followed by many more, was installed in 1899. More recent products, such as arc-welding sets and A.C. commutator motors, have been described from time to time in our columns.

When in 1928 the original private partnership of J. H. Holmes and Co. ceased to exist, the work was carried on by J. H. Holmes and Co., Ltd., in the old factory in Portland-road, Newcastle-on-Tyne. Two years after the change, however, new works were built adjacent to the existing New Town Works of A. Reyrolle and Co., Ltd. The Holmes works have since been incorporated in those of the latter firm, and manufacture is now carried out with the most modern plant and equipment.

In these days of super-power stations, extra-high-tension transmission, and all the ramifications of modern electricity supply, the work of pioneers is apt to be overlooked, but those who have witnessed the developments of the past fifty years rarely fail to appreciate a little history. Those who, like Mr. J. H. Holmes, began when there was little, if any, data to guide designs, must have had to face many difficulties and disappointments, and they have every right to be proud of their achievements.

Coal-Oil Mixtures.

In a paper read before the Institute of Marine Engineers on Tuesday evening, October 17th, Dr. W. R. Ormandy and Dr. J. Burns dealt with the recovery of oil from coal. They treated the problem from both the national and Empire standpoint, and considered the present position of the gas and coke oven industries, also the low-temperature carbonisation of coal and the hydrogenation of coal and coal tars. The last section of the paper, which dealt with the recent progress made in the production and application of coal oil mixtures, is reproduced below.

Coal-oil Mixtures.—Attempts to produce stability in coal-oil mixtures have proceeded along three main lines :—

1. By grinding the coal in oil to colloidal dimensions.
2. By protecting coal particles suspended in oil by gel-forming materials, such as oil-soluble soaps.
3. By "peptising" the coal particles by means of coal tar distillates.

Granted that complete success is or can be attained in the production of a stable coal-oil mixture, it is interesting to discuss the possible application of such mixtures and the extent of such applications. Present-day indications are that the coal-oil mixtures will be used solely for steam-raising purposes, though claims have been made that such fuels are suitable for use in compression-ignition engines. In view of the fact, however, that the ash content allowable in a Diesel fuel is of the order of 0·2 per cent., it is clear that the coal employed would have to be, to all intents and purposes, free from ash. In fact, an ash content lower than the inherent ash of bituminous coals would be necessary, which ash it is impossible to remove mechanically.

In so far as the application of coal-oil mixtures for steam-raising purposes is concerned, it is probable that such application will be confined to marine purposes, where the handling and storage advantages are of prime importance and a liquid fuel enjoys a premium over a solid fuel. Fuel oil has no real advantages over coal or pulverised fuel for stationary steam-raising plants except in a few isolated cases. This attitude, it is interesting to note, is taken, not only by the coal producers, but is also recognised by some of the leading authorities in the oil world. Mr. J. B. Aug Kessler, in his admirable lecture given at the recent World Petroleum Congress, deals at length with what he terms legitimate and illegitimate uses of oil, and he undoubtedly deprecates the forced sale of mineral oil for use where coal is obviously more suitable, having regard to economic factors. Further, the present uneconomically low prices for fuel oil are not likely to remain when the oil producers put their house in order and rationalise the output of crude oil.

The quantity of fuel oil employed for steam-raising purposes in the mercantile marine and Navy at the present time amounts to approximately one and three-quarter million tons per annum. If we assume the general use of a mixture consisting of 60 parts of oil with 40 parts of coal, the coal requirements in excess of present-day requirements would amount to approximately one million tons. It will be appreciated that this figure represents only a very small percentage of the total yearly output of coal, which approximates on an average to 230,000,000 tons. It is well to keep these facts in mind when considering the rather exaggerated claims made as to the benefits to the mining industry which would accrue from the general adoption of coal-oil mixtures. It is generally accepted, too, that the most suitable type of coal for the preparation of coal-oil mixtures is the soft, easily ground bituminous type of reasonably low ash content, and washed slack of this type of coal would answer the purpose. Thus the development of coal-oil mixtures would provide an outlet for a type of coal which must be raised and for which at present there is not sufficient market. This market, however, would be a true market and not one which would be developed at the expense of another grade of coal.

There are obvious difficulties to be overcome before the use of coal-oil mixtures for marine purposes could become general. In the first place, it is doubtful if a degree of stability of the mixture could be attained which would allow of the mixture being prepared at one central station and shipped in tankers and stored at foreign ports where oil is available at the present time. The alternative is the setting up of grinding and mixing stations at widely separated centres, which in turn involves the transport of coal to such centres. It is more likely that coal-oil mixtures will be confined to coastal traffic or wherever fuel can be bunkered for a round trip. For ocean-going vessels there is nothing to prevent the outward trip being made with coal-oil fuel and the home trip with straight fuel oil, as the handling, storage, and burning equipment is the same in both cases.

In addition to the recognised methods of producing stable coal-oil mixtures, there is another phase of activity in this direction which merits attention. Much work has been done and is being done on the heat treatment of suspensions of coal in oil. It is claimed that, under the conditions employed, yields of low boiling oils can be obtained from coal greater than can be got by low-temperature carbonisation methods, while the remainder of the product from the treatment, after distilling off the low boiling fractions, is in the form of a highly stable coal-oil mixture. In some cases it is claimed that the heat treatment of coal in suspension in oil gives the coal particles a spongy-like surface with a considerable diminution in the apparent specific gravity of the particle, leading to the production of a stable coal-in-oil mixture. In other cases it is claimed that under the specific conditions of treatment the coal particles are actually disintegrated and are more nearly reduced to colloidal dimensions.

One must regretfully admit that science and technology working together tend to reduce the amount of fuel consumed rather than to increase it. Existing industries using coal achieve their object with less coal than was formerly employed, and the increase in trade which might have been expected has not yet resulted. The gas industry has increased its output of gas and coke very steadily for a number of years, and this without the necessity for purchasing more coal. The increased sales have been met by the improvements in the control and design of the manufacturing plants employed.

In considering the coal situation of the country it is necessary to keep a balanced outlook. Many schemes are being put forward which involve millions of capital, without the repercussions of the development of such schemes being fully appreciated. In any case, it is well to remember that the lighting up and working of two modern large blast-furnaces would lead to an increased demand for about one million tons per annum of coking slack. A slight recovery will produce effects on the coal industry, which it will take new industries, of the types dealt with in this paper, many years to equal.

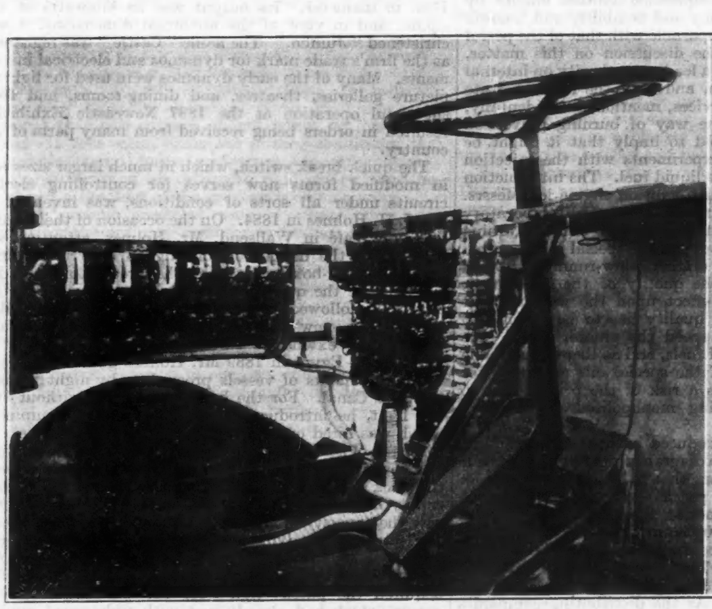
Regenerative Trolley Omnibuses.

The use of regenerative control equipments on trolley omnibuses appears to be rapidly increasing. Apart from B.T.H. regenerative equipments already in service, others are being supplied. Four are on order for the Huddersfield Corporation and fifteen for the Walsall Corporation. Two of the Huddersfield vehicles are being fitted with B.T.H. motor and control gear to the order of Karrier Motors, Ltd., one with exactly the same equipment to the order of the Sunbeam Motor Car Co., Ltd., and one with B.T.H. control gear to the order of Ransomes, Sims and Jefferies, Ltd. The regenerative control gear and motors are similar in all respects to those supplied by the B.T.H. Company to the Sunbeam Motor Car Company for its Walsall Corporation contract.

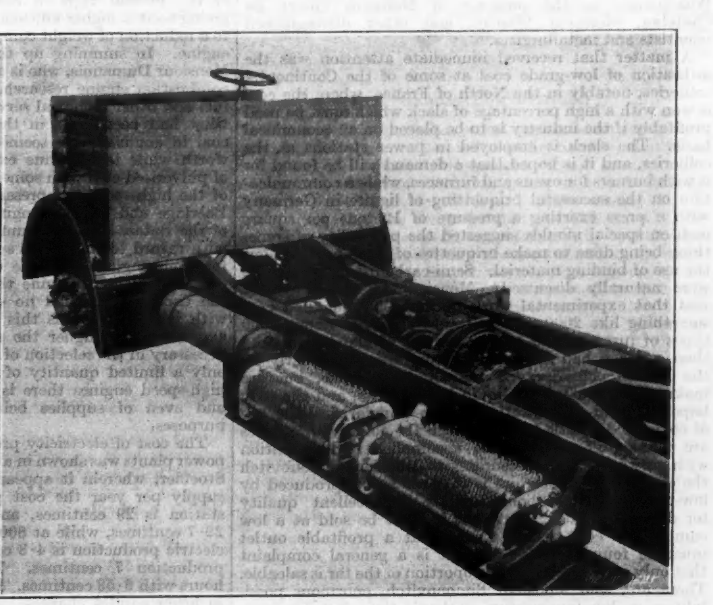
The left-hand illustration above shows the contactor panels and master controller mounted in the driver's cab. To facilitate wiring, and to enable the connections to be examined, the wires are run on the front of the panels. The wiring of the various parts of the equipment was carried out by the Sunbeam Motor Car Company, the cables being drawn into flexible steel tubing as shown. The shunt field contactors mounted on the front dash open and close against rubber buffers and are practically noiseless in operation. The patented B.T.H. gearless master controller is coupled to a special pedal plate mechanism designed by the Sunbeam Motor Car Company, and requires a very light pressure to operate it.

The motor, to be seen in the right-hand illustration, which also shows the main resistances, is the makers' latest light-weight type of machine. It is sufficiently compact to be mounted under the floor of the vehicle, and apart from the fact that it is very accessible, the drive to the back axle is short. Vitreous enamel tubes mounted in a frame with a louvred cover are used for the shunt resistance.

As shown in the right-hand illustration, the main resistances are mounted at the side of the chassis. They are of the B.T.H. rustless unbreakable type, and are particularly suitable for road vehicle service. Connections are made from the resistance grids to a terminal bar mounted on the U-shaped end frame, and incoming leads are brought to a point between the two boxes where access to the terminals can readily be gained. While the resistances are protected below from the ingress of dirt and moisture, air is free to pass through from the front to ensure adequate ventilation.



CONTACTOR PANELS AND MASTER CONTROLLER IN DRIVER'S CAB



MOTOR AND MAIN RESISTANCES

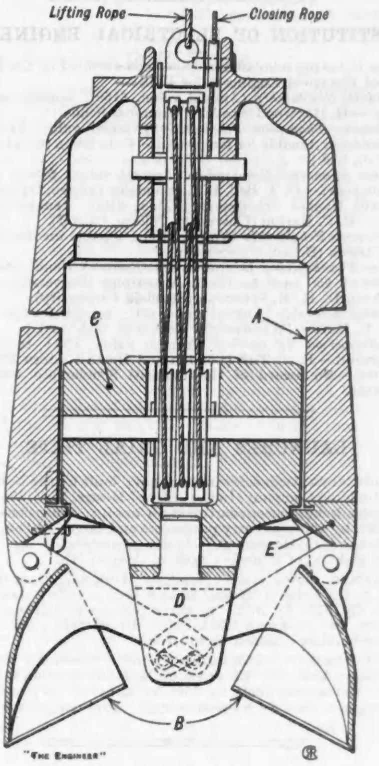
A New Microphone.

A new carbon microphone for which important advantages are claimed has been introduced by Marconi's Wireless Telegraph Company, Ltd. It has been designed to meet the demand for a reliable low priced instrument, with good operating properties, and is said to be practically free from background noises. The microphone consists of a double-cell capsule, with a light diaphragm, the complete instrument being suspended within a light but robust metal frame, which can be suspended or be inserted in a pedestal or in a hand grip, according to requirements. The carbon depth which regulates the frequency response has been carefully chosen to give a satisfactory response over the whole useful frequency range, and as the height of each cell is only 2·5 cm., the tendency to pack is considerably reduced. As the instrument is effectively sealed, its characteristics are not affected by weather or temperature.

Extensive tests are said to have shown that ground noise is of the same order as normal speech at about 50 m. from the microphone. Owing, moreover, to the fact that the carbon microphone requires no immediately adjacent amplifier unit with its attendant sound baffle effects, the polar diagram of response at different frequencies is considerably better than that of the condenser instrument. The new instrument has an exceptionally wide angle of pick up. When used with a suitable transformer and a current of approximately 25 milliampères, the voltage produced at the grid of the first valve of the amplifier is about 100 millivolts, with speech at about 25 cm., as compared with 3 millivolts given by a standard condenser microphone. Owing to the large output of the microphone, considerable lengths of cable can be used between the instrument and amplifier without risk of induction. No adjustments are needed, and the microphone has been made suitable for the same terminal connections as those for the Marconi Reisz microphone. The new instrument can therefore readily take the place of the latter, and, if necessary, as many as four microphones can be connected in parallel.

A Small Excavating Grab.

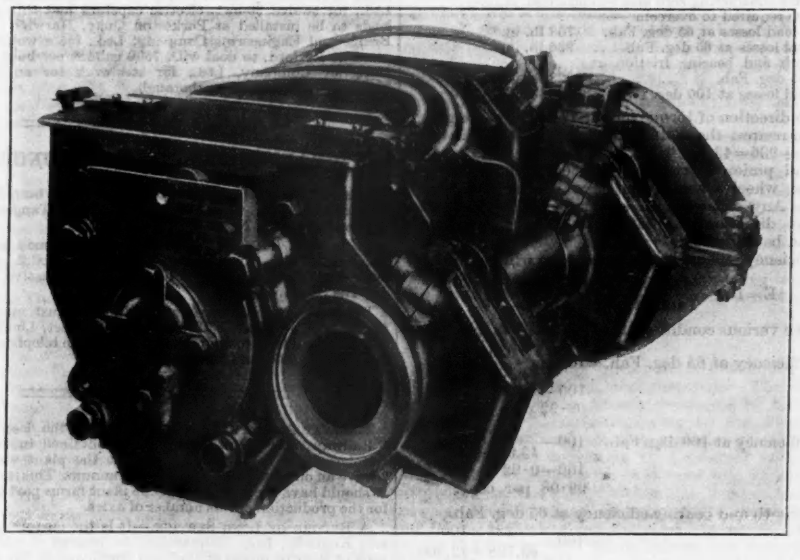
In the September issue of *Science et Industrie*, of Paris, there is described and illustrated (we reproduce one of their illustrations) a little excavating grab, which is obviously specially applicable to such services as helping in the sinking of hollow piles or tube wells. It is intended to be only from some 6in. to 12in. in diameter and consequently its mechanism has to be very compact. In consequence reliance for the digging action is not placed on the usual system of compound levers, but the grab is provided with a massive shell A, which is of sufficient weight to drive the buckets B into the soil, and is so strongly constructed that it may be dropped to drive the buckets into the ground. The heavy piston C assists in this action and also ensures the opening of the buckets. Closing of the buckets, when they have penetrated the soil, is effected by the rope tackle drawing up the piston and the bucket arms. It will be noticed that there are slotted holes for the pins at the end of fork D. The buckets are pivoted to the ring E, which is readily detachable from the shell A, so that alternative arrangements of buckets may be employed according to the class of soil being dredged.



Excavating Grab

Electric Tramcar Equipments.

The traction department of Crompton Parkinson, Ltd., is delivering thirty sets of "Crompton West" electric tramcar equipments to the Liverpool Corporation. The motors are being made at the Chelmsford works and the controllers and circuit breakers at the Brighton works of Allen West. Each of the new cars for which the equipments are being constructed will be provided with four 36 H.P. motors of the type illustrated. Two of each of the four machines will be permanently connected in series, and the two pairs will be arranged for series-parallel control in the ordinary way. A special feature of the motors is that they are designed to permit of a lower car floor level than usual. They are light-weight, box-frame, interpole, self-ventilated machines. In the interior light alloy metal is employed wherever possible, and also for the gear case. Steel inserts are provided at all points of attachment. Class "B" insulation is used throughout, the armature and field coils being bakelised to make them impervious to moisture, accurate to size, and to give them good heat-dissipating qualities. Quiet running is secured by the use of grease lubrication and by the dynamic balancing of the armature.



36 H.P. Electric Tramcar Motor

An improved parallel flow self-ventilation system differs from that normally adopted in that the two streams of air for cooling the armature core and coil surfaces respectively are kept separate throughout their passage in the machine. In this way the correct air flow required can be provided in either path, and another special point in the design is that care has been taken to arrange the air inlets so that foreign matter cannot gain access to the interior of the motor.

The cam-type controllers have four series, four parallel, and six rheostatic brake notches. The rheostatic brake operates in conjunction with the air brake, and both are controlled by the main controller handle when moved to the brake position. In place of the usual air brake attachment on the controller cap plate, the air-brake-operating mechanism is built integral with the controller top.

An improved single-spring notch regulator mechanism not only operates on all the power notches, but can, if necessary, be arranged to operate in connection with the cut-off of the air brake before the controller is moved to the first power position. The main operating handle drives through gearing a horizontal drum, which is continuously rotated and forms the controlling connection with the motors for motoring and braking. At the end of the brake drum shaft spur gearing drives the horizontal cam shaft, and with this arrangement it is possible to provide ten contactor units without making the overall width of the controller greater than that of other types of controllers having a smaller number of contactor elements. The increased number of contactor elements enables improved circuit arrangements to be provided, thereby ensuring that all arc rupturing is confined to the contactor units and never occurs on the drum contacts. Each contactor element has a blow-out coil built up into a complete unit, which can readily be removed from the controller for inspection of the contacts, the controller being isolated at the same time.

On the lower horizontal shaft there are two co-axial drums. One is the reverser drum controlled by a separate removable reverse key on the cap plate. In addition to the contacts for reversing the motors it carries contacts for sanding during run-back braking, and for the warning lights which are connected in circuit at each end of the car when rheostatic braking is employed. The other drum is for isolating either pair of motors on the occasion of a fault, while permitting full operation of the remaining machines. Two overload adjustable circuit breakers are being fitted to each car, the adjusting device being sealed to prevent unauthorised settings.

Canadian Engineering News.

(By our Canadian Correspondent.)

Highways.

In keeping with its good roads policy, Canada's expenditure last year on highway construction amounted to 45,867,491 dollars, including subsidies from the Dominion Government for relief work and for the elimination of rural level railway crossings. Expenditures on bridges and ferries amounted to 4,164,018 dollars, making a total expenditure of 50,031,509 dollars. Heavy expenditure in Northern Ontario included much clearing of bush, establishment of construction camps, &c., for the Trans-Canada highway. The surfaced highway mileage in Canada at the end of 1932 amounted to 91,312 miles and unsurfaced roads to 307,008, making a total of 398,320. This total includes all roads outside incorporated cities, towns and villages under the jurisdiction of the Provincial Highway Departments. Gravel roads increased from 75,081 miles to 80,183. Cement concrete roads are found almost entirely in Ontario and Quebec, only 3 per cent. of the total being in other provinces. The increase in this high-class type of road was 433 miles, or from 1584 to 2017 miles.

Engineering Standards.

The Dominion Department of Public Works recently included in the standard form of contract a clause referring to the standards of the Canadian Engineering Standards Association, reading as follows :—"Unless otherwise expressly provided in the specification, all goods or materials supplied shall conform to the specifications of the Canadian Engineering Standards Association, or the specifications of the recognised Standards Association in the country of origin in the Empire, and in cases where goods or materials are required, which are not of Canadian production or manufacture, the standards above mentioned shall apply." This action has a direct bearing on the development of Empire trade when it is associated with the Order-in-Council issued by the Privy Council of the Dominion in March last, which stated that whatever material or goods not produced or manufactured in Canada are required by any Government department, or by any contractor engaged in Government work, provision shall be made in the tenders that such material shall be of Empire production or manufacture, and that, where standards are specified, an Empire standard shall be adopted unless it is conclusively shown that goods or materials in question cannot be obtained in the Empire. It was assumed that this applied to the Canadian National Railways, and every board, commission, or other similar body under the control of Parliament. Continued efforts are thus being made to secure harmony wherever possible between Canadian and British specifications covering the same field.

Big Development for Newfoundland.

Work on a 21,000,000-dollar development project for Newfoundland's resources will begin this autumn if it receives the approval of the Government and the Royal Commission investigating the Island Dominion's financial position. The Boston engineering firm of Chase and Gilbert has been retained to make plans for the project, which contemplates the taking over of improvement and development work by a British-Canadian syndicate in return for fee simple rights over certain properties which the syndicate holds under lease.

ENGINEERS' GERMAN CIRCLE.

There was a large attendance of members and friends of the Engineers' German Circle on Monday evening last, when the inaugural lecture was given by Dr. Nägel, of Dresden. The meeting was held in the handsomely reconditioned hall of the Institution of Mechanical Engineers. At an exceptionally busy time, the German Ambassador, Dr. Leopold von Hoesch, found an opportunity to spend a short while with the members of the Circle and expressed his own and his Government's interest in the work of the Circle and the sister Circle of English-speaking engineers in Berlin, which, he said, were bringing together the engineers of the two countries and working for a deeper understanding between the two nations. Dr. Nägel took as his subject research on the process of combustion in high-speed internal combustion engines, and, in a lecture fully illustrated by lantern slides, gave his hearers an insight into his capacity for teaching and the strong spirit of leadership which is shown alike in the research work of his Dresden laboratory and his guidance of the scientific work of the Verein Deutscher Ingenieure. He described the laboratory methods employed for the study of flame propagation in cylindrical bombs and pressure vessels, and the injection of fuel oils into highly compressed atmospheres. He showed that, by means of the oscillograph and quartz indicator, and an electrical method of measuring valve movement, a very complete picture of what happened in the engine cylinder could now be obtained. Examples were given showing possible applications of the knowledge so obtained in the development of the use of tar oils in high-speed airless injection engines, and the problems of starting engines of the ante-chamber type from cold. The lecture was followed by an informal dinner, held at the Anglo-German Club.

CATALOGUES.

Greenwood and Batley, Ltd., Leeds.—A folder illustrating "Greenbat" electric trucks.

Demag A.G., Duisburg.—A 200-page book illustrating and describing the firm's products.

F. A. Welling and Co., Ltd., 8, Union-court, E.C.2.—A booklet on "Cinch" expansion anchor bolts.

Oliver Ashworth and Co., Ltd., Castle Grounds, Bury.—Catalogues of second-hand machinery and plant of all descriptions.

Alfred Herbert, Ltd., Coventry.—A new publication dealing in some detail with the firm's range of capstan and turret lathes.

Fescol, Ltd., 101, Grosvenor-road, S.W.1.—Catalogue N 1 on the electro-chemical deposition of metals by the "Fescol" process.

Colvilles, Ltd., 195, West George-street, Glasgow, C.2.—A brochure on combating corrosion by the use of "Dalzo" rust-resisting steel.

Samuel Fox and Co., Ltd., Stocksbridge Works, near Sheffield.—A booklet entitled "The Case Hardening of Special Steels by Nitrogen."

Thos. Robinson and Son, Ltd., Railway Works, Rochdale. —A book of over 200 pages dealing in detail with the firm's woodworking machinery.

Musgrave and Co., Ltd., Belfast.—Copies of two new catalogues just issued for "U" and "M" type fans, and high-efficiency fans respectively.

Sturtevant Engineering Company, Ltd., 147, Queen Victoria-street, E.C.4.—Publication No. 1243 dealing with industrial process ventilation.

Stedall-Dowding Machine Tool Company, 145, St. John-street, E.C.1.—Pamphlet in English describing the Lindner automatic engraving machine.

James Gordon and Co., Ltd., Regent House, Kingsway, W.C.2.—Pamphlet H 2, dealing briefly with Hagan automatic control for steel and gas works.

A. Reyrolle and Co., Ltd., Hebburn-on-Tyne.—One of the firm's "Multum in Parvo" catalogues containing a set of leaflets describing their products.

Flexotube (Liverpool), Ltd., 2, Strand-street, Liverpool.—A catalogue on mechanical scale removal by motor-driven tube and surface scaling machines, rotary cutters, and brushes.

Westinghouse Brake and Saxby Signal Company, Ltd., 82, York-road, N.1.—The following sections of the firm's new signal catalogue :—Section A, Sub-section D, "Electric Point Detection and Locking" ; Section B, Sub-section B, "Electric Signal Machines and Signals" ; Section B, Sub-section C, "E.P. Semaphore Signals, &c." ; Section B, Sub-section D, "Route Indicators."

Efficiency Tests on 600 H.P. Increasing Gear

By H. E. MERRITT, D.Sc.

SINCE the opportunity of carrying out accurate full-load efficiency tests on reducing or increasing gear units does not often present itself, the data derived from the tests described below may possibly be of interest to both designers and users of reduction gearing.

The units in question were designed to transmit 600 horse-power continuously, increasing speed from 180 to 935 r.p.m., and comprised pinions of 0·55 carbon forged steel, solid with shafts, gearing with wheels having 0·4 rolled carbon steel rims shrunk on to cast iron centres. High-speed and low-speed shafts were mounted on roller bearings and lubrication was by splash. The centre distance was 24in., and the wheel and pinion had 161 and 31 teeth respectively, of British standard 20 deg. pressure angle tooth form, 30 deg. spiral angle.

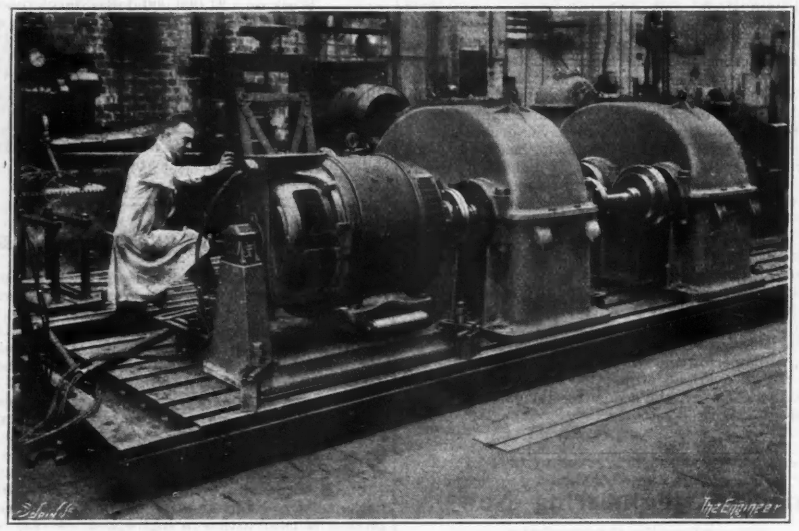


FIG. 1—ARRANGEMENT OF GEARS ON TEST BED

Since two identical gears were required, and full-load efficiency tests were specified before the manufacture of the gears was commenced, arrangements were made to carry out a back-to-back or power circulation test. One pinion shaft was therefore extended and a temporary cover made so that the gears might be coupled up in line.

The wheel and pinion shafts were connected in pairs by high-tensile torsion shafts, one of the couplings on the pinion torsion shaft being left undrilled. Prior to the test proper, one half of this coupling was prevented from rotating and to the other was attached a lever, radius 72in., to the end of which were suspended weights producing, together with the weight of the lever, a torque corresponding to 635 horse-power at 935 r.p.m. This produced, by reason of the flexibility of the torsion shafts, a total angular deflection of one half coupling relative to the other of approximately 3in. at the rim, and in this position the relative positions of the coupling halves were marked. The coupling was then drilled and reamed in this position. Clearly, when the coupling was bolted up in the full torque position, all the gears and bearings would be subjected to full-load conditions, and the power required to rotate this closed system from an external source would represent the total losses in the two gears.

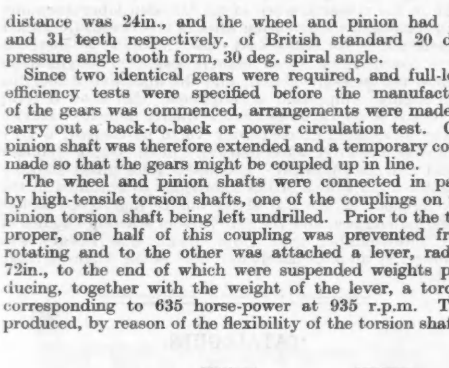


FIG. 2—DIAGRAM SHOWING ARRANGEMENT

For this purpose the drive was taken from a 40 horse-power variable-speed motor with suspended stator, whereby the torque reaction could be measured mechanically by a lever arm and spring balance in the usual way. The general arrangement of the test is shown in the photograph, Fig. 1, and the diagram, Fig. 2.

The tests comprised measurements of the losses with the torsion coupling disconnected and with the oil at a temperature of 65 deg. Fah., followed by measurements of the full load losses at the initial temperature of 65 deg. Fah., and after running for two hours (final temperature, 100 deg. Fah.).

Numerous similar tests on gears of various kinds, mounted on roller bearings, had shown that the total losses in a gear running at constant speed and varying loads could be divided into two parts, namely, a no-load loss representing oil drag in gears and bearings, and constant at all loads, and a net load loss representing the friction due to load between the teeth and in the bearings and directly proportional to the load. On this basis, which from all the evidence is substantially true, the no-load and net-load losses and the gear tooth and overall efficiencies may be determined for any load from observations at no-load and full load.

The observations taken during the tests were as follow :

Pinion speed	935 r.p.m.
Radius of coupling torque arm ..	72in.
Equivalent weight on coupling torque arm..	595 lb.
Pinion torque..	72 × 595 = 42,800 lb. in.
Horse-power circulated through each gear	635
Motor torque arm	35·4in.
Motor spring balance readings—	
No load at 65 deg. Fah.	20·0 lb.
Full load at 65 deg. Fah. ..	26·5 lb.
Full load at 100 deg. Fah. ..	22·5 lb.
(After subtracting zero and windage corrections)	
Torque required to overcome—	
No load losses at 65 deg. Fah.	708 lb. in.
Total losses at 65 deg. Fah. ..	936 lb. in.
Tooth and bearing friction at 65 deg. Fah.	228 lb. in.
Total losses at 100 deg. Fah. ..	796 lb. in.

For the direction of torque for which readings are given, the pinion nearest the motor carried a torque at the teeth of 42,800 + 936 = 43,736 lb. in. at 65 deg. Fah.; whilst the second pinion carries only 42,800 lb. in. The first drove the wheel whereas the second was the driven member. Any difference in efficiency of the gears due to relative direction of rotation and torque is so small that it can be neglected.

The efficiency reckoned as a percentage will be given by

$$E = 100 - \frac{\text{Driving torque} \times 100}{\text{Total of pinion torques}}$$

and for the various conditions is found to be as follows :—

$$\text{Overall efficiency at 65 deg. Fah.} = 100 - \frac{936 \times 100}{43{,}736 + 42{,}800}$$
$$= 100 - 1{\cdot}08$$
$$= 98{\cdot}92 \text{ per cent.}$$

$$\text{Overall efficiency at 100 deg. Fah.} = 100 - \frac{796 \times 100}{43{,}596 + 42{,}800}$$
$$= 100 - 0{\cdot}92$$
$$= 99{\cdot}08 \text{ per cent.}$$

Net gear tooth and bearing efficiency at 65 deg. Fah.

$$= 100 - \frac{228 \times 100}{43{,}128 + 42{,}800}$$
$$= 100 - 0{\cdot}27$$
$$= 99{\cdot}73 \text{ per cent.}$$

The probable accuracy of the results given above may be analysed as follows :—

Accuracy of measurement of pinion torque arm radius	$= \pm\frac{1}{8}$in. = 0·2 per cent. on total torque
Accuracy of measurement of applied weights	= ±2 lb. = 0·3 per cent.
Possible error due to friction in coupling spigot and mis-alignment in drilling couplings	= 2·0 per cent.
Possible total error in pinion torque..	= 2·5 per cent.
Possible error of observation of spring balance	= ±0·25 lb.
Possible error in taking difference ..	= 0·5 lb.
Possible error in driving torque ..	= 0·5 × 34·5 lb. in. = 17 lb. in.

Since the full load loss is only about 1 per cent., the possible error in pinion torque represents only 0·025 of 1 per cent. The percentage error in efficiency value due to error of observation of the spring balance is 17 × 100/85,600 = 0·02 of 1 per cent.; hence the probable error of the efficiency values will be less than 0·05 of 1 per cent.

Acknowledgments are due to David Brown and Sons (Huddersfield), Ltd., for permission to publish these results.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE following scholarships have been awarded by the Institution of Electrical Engineers for 1933 :—

Duddell Scholarship (Annual value, £150 ; tenable for three years).—H. Haywood (Staveley Grammar School).

Silvanus Thompson Scholarship (Annual value, £100, plus tuition fees ; tenable for two years).—P. L. Olsen (C. A. Parsons and Co., Ltd.).

Swan Memorial Scholarship (Annual value, £120 ; tenable for one year).—D. A. Bell, B.A. (Magdalen College, Oxford).

David Hughes Scholarship (Value, £100 ; tenable for one year).—R. C. Barton (University College, Cardiff).

Salomons Scholarship (Value, £100 ; tenable for one year).—R. S. Quick (Bristol University).

War Thanksgiving Education and Research Fund (No. 1).—Grants of £50 each to R. G. Armstrong (University College, London), D. H. R. Whyman (Sheffield University).

Paul Scholarship (Annual value, £50 ; tenable for two years).—R. P. Kinsey (Wandsworth Technical Institute).

Thorrowgood Scholarship (Annual value, £25 ; tenable for two years).—L. F. Tuff (London and North-Eastern Railway).

NOTE.—No award of the Ferranti Scholarship was made this year.

LAUNCHES AND TRIAL TRIPS.

AAGTEKERK, twin-screw motor ship ; built by the Netherland Shipbuilding Company, to the order of Messrs. N. V. Vereenigde Nederlandsche Scheepvaartmaatsch appij ; dimensions, 493ft. by 60ft. by 40ft.; to carry passengers and cargo. Oil engines, of "Stork-A.E.G.-Hesselman" type ; constructed by Messrs. Stork and Co., of Hengelo ; launch, October 7th.

ISIPINGO, motor vessel ; built by Workman, Clark and Co., Ltd., to the order of Messrs. Andrew Weir and Co ; dimensions, 425ft. by 57ft. by 37ft.; to carry passengers and cargo. Oil engines, of Workman Clark-Sulzer Diesel type ; constructed by the builders ; launch October 9th.

BEN HENSHAW, motor tanker ; built by Rowhedge Ironworks Company, Ltd.; to the order of National Benzole Company. Ltd.; dimensions, 135ft. by 25ft. by 12ft.; to carry oil in bulk, Oil engines, twin 5 J 8 Gardner type ; trial trip, October 13th.

CONTRACTS.

MELDRUMS, Ltd., Timperley, have received the order to fit their patent sprinkler stokers to seven boilers at the Prestwich Mental Hospital.

RADIOVISOR PARENT, Ltd., 28, Little Russell-street, W.C.1, has received an order for equipping the power station of the Wimbledon Corporation with its industrial smoke indicator.

FRANK HOW AND CO., Ltd., of Stratford, have been accorded the whole of the contract for the Egyptian Delta Light Railways. They have also received a further order for 10,000 gallons of cylinder oils from the Egyptian State Railways.

RICHARD DUNSTON, Ltd., of Thorne, Yorkshire, has received notification from the War Office of the acceptance of its tender for a single-screw Diesel-engined steel vessel, with dimensions 85ft. by 17½ft. by 7ft. The propelling machinery will consist of a 120 H.P. "Mirrlees" engine, complete with the necessary auxiliaries.

THE L.N.E.R. reports that the undermentioned contracts have been placed :—Mitchell Conveyor and Transport Company, Ltd., for modifications to the feeder apparatus of the coaling plant at Hornsey locomotive depôt ; Cowans, Sheldon and Co., Ltd., for twelve 30-cwt. electric capstans and thirty-one fairleads to be installed at Parkeston Quay, Harwich ; Horseley Bridge and Engineering Company, Ltd., for a water-softening plant at Retford, to deal with 7500 gallons per hour ; and the Butterley Company, Ltd., for steelwork for an overbridge between Yaxley and Peterborough.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

GENT AND CO., Ltd., have removed their branch office at Newcastle-on-Tyne from Blackett-street to "Tangent House," Leazes Park-road, Newcastle-on-Tyne, 2.

COCHRANES (MIDDLESBRO'), Ltd., have opened an office in London at 11, Arundel-street, Strand, W.C.2, and have appointed Mr. E. M. Gill to be sales representative in London and the South.

BRITISH ARCA REGULATORS, Ltd., have just moved to the fourth floor of Windsor House, Victoria-street, London, S.W.1. The postal address remains as before, and the telephone numbers are Victoria 2275 and 7456.

RAILWAY AXLE PLANT FOR RUSSIA.—In the description of a "Railway Axle Plant for Russia," contained in our issue of October 6th last, it was stated that the plant was designed to give an output of 270,000 axles per annum. This is not correct. It should have been stated that the plant forms part of a scheme for the production of this number of axles.

A RECORD OF LONG SERVICE.—It is the custom of Glenfield and Kennedy, Ltd., Kilmarnock, to present a gold medal to each of their members of staff and employees on the attainment of fifty years' continuous service with the firm. Mr. W. W. Muir, buyer, is the latest member who has qualified for this distinction, bringing the number of medals presented during the last four years up to twenty-six.

INGENIEURS CIVILS : BRITISH SECTION.—The following gentlemen have been elected for the session 1933–1934 as the Council of the British Section of the Société des Ingénieurs Civils de France :—President : W. R. Howard, M.I. Struct. E. Vice-Presidents : H. K. Scott, M. Inst. M.M.; R. H. Stanger, A.M. Inst. C.E. Members : W. J. E. Binnie, W. T. Halcrow, M. Inst. C.E., Sir Geo. Humphreys, Sir Henry Japp, H. A. Reed, M. Inst. C.E., Gilbert Szlumper. Honorary Treasurer : T. J. Gueritte. Honorary Secretary : A. Kirkwood Dodds, M.I. Struct. E.

SCHOLARSHIPS.—The North-East Coast Institution of Engineers and Shipbuilders has made the following awards :—Institution Scholarship, value £100 per annum, to William Leslie Stewart ; grant of £50 to John Campbell Matthew. George Mitchell Harroway Scholarship, value £100 per annum, to Guy Gowland Harforth. In addition to the above awards, the Scholarships of Mr. E. J. C. Statham (1931 scholar), and Mr. John Cecil Brown (1932 scholar) have been continued for a further year. The total value of the above scholarships and grants awarded by the Institution is £450.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Import and Export Figures.

The Board of Trade returns for September show that the British iron and steel trades have maintained their position. Comparing the volume of business during the first nine months of the current year with that of 1931 and 1932 there has been a decrease in the imports and an increase in exports. The imports of pig iron, if we except the arrivals from India, were so small that the monthly totals have little importance. For the first nine months of the year the imports of forge and foundry iron were only 27,591 tons, of which 20,000 tons came from India. The total imports of basic iron to the end of September was 40,333 tons, of which all but 30 tons came from India. The imports of blooms and billets during September reached 24,871 tons, compared with 27,324 tons in September, 1932, and 41,590 tons in September, 1931. Imports of girders, beams, and joists from the Continent are slightly in excess of last year, and for the first nine months total 58,936 tons against 53,148 tons for the same period of 1932, but show a distinct reduction when compared with the 1931 figures of 74,767 tons. The imports of plates and sheets for the nine months dropped to 30,233 tons, compared with 60,509 tons last year, whilst 52,000 tons of hoop and strip were brought in against 85,410 tons in 1932. On the export side, pig iron shows a decline from 89,641 tons for the first nine months of 1932 to 75,601 tons this year. Bars, rods, angles, and sections are fairly consistent at 4711 tons for the nine months, against 4984 tons last year. Exports of plates and sheets also are down, the total for the nine months being 56,611 tons, whilst for the same period last year the figure was 85,560 tons. On the other hand, plates and sheets, under ⅛in. thick, have improved to 95,825 tons, against 84,293 tons for the nine months in 1932. The exports of galvanised sheets, however, are not so good, the total being 187,214 tons for the nine months ended September 30th, compared with 215,104 tons for the same period of 1932. Tubes, cast and wrought, show an improvement, whilst the exports of new steel rails are up to 52,676 tons, compared with 32,505 tons last year. Other classes of railway material also show an improvement.

Machinery Exports.

Although the exports of machinery show a decline in value over the nine months ending September 30th this year compared with the corresponding period in the two previous years, the figures for September show an increase. For the nine months the total value was £19,771,229, compared with £22,654,449 last year. On the other hand, the value of the September machinery exports was £2,306,437, compared with £1,881,549 in 1932. The value of the export trade in prime movers totalled £216,299, compared with £161,626 in the corresponding month of last year. Of this total British South Africa took £31,071, and European countries £21,727; Australia taking machinery to the value of £14,151. The export of machine tools was valued at £88,000, of which Soviet Russia was the largest buyer, taking £42,317, British India being next at £9856. In September last year the exports were valued at £193,000, but the difference is largely accounted for by the fact that in that month exports to Russia were valued at £134,841. Agricultural machinery to the value of £50,787 was exported in September against £37,181 in September, 1932. The exports of textile machinery also showed an improvement to £385,077, against £364,863 in September of last year.

The Continental Steel Position.

The iron and steel markets of the world are not so easily affected by political influences as are some commodity markets, and there are good grounds for believing that, notwithstanding the disturbances created in international politics by Germany's withdrawal from the League, the steel trade will not be much upset. To some extent the Continental industries will feel the re-percussion of political events, but this is largely because they have Cartelised the principal European trades so that anything which affects, for instance, Germany, must also affect France, Belgium, and Luxemburg, and *vice versâ*. At the present moment it is probable that the industries are not likely to be worse off, since for months past they have been existing on a hand-to-mouth flow of orders. Recently, a number of meetings have been held at which efforts have been made to smooth out some of the more obvious difficulties in the way of reconciling the merchants to the steel makers' methods of selling through comptoirs, but apparently little success has attended their endeavours. The Belgian industry has been in a worse position then either the French or German, but these latter appear to be now threatened with conditions almost as bad. It is reported that the Cartel has now to meet claims from the French and German steel makers for larger shares of the orders received, and as the Belgian industry is equally pressing, a difficult situation has arisen.

Conditions in America.

The prospect of competition from the American steel works in the export markets must be causing lively apprehension to the Continental manufacturers; but, for the time being, the Americans seem too preoccupied with affairs in their domestic market to set out to capture export trade. The first flush of buying which followed America's departure from the gold standard and the adoption of President Roosevelt's recovery plan has passed; but if the American steel trade did not benefit as much as some American industries, at least it appears to have maintained most of the ground it then gained. The steel "code," however, has not so far fulfilled expectations. It has certainly eliminated speculative buying, and to this is attributed the reduction in the United States Steel Corporation's unfilled orders at the end of September by 114,704 tons to 1,775,740 tons, which is the lowest figure on record. Another disappointment to the steel trade has been the absence of railway buying. It was understood when the code was entered upon that the Government would assist the railway companies to place long-awaited orders for rails. It now transpires that although the Government is willing to assist the railways financially, the latter decline to place orders unless prices are reduced. The steel makers retort that their costs and wages are increasing, and that they can scarcely afford to sell even at current prices, and there the matter rests.

Iron and Steel Production.

The monthly figures for iron and steel production issued by the National Federation of Iron and Steel Manufacturers show that outputs were maintained during September. At the end of the month seventy-four furnaces were in blast, an increase of one since the end of August, two having been blown in and one having ceased operations. Although it is not stated in the Federation's report one of the furnaces was started up on hematite at the Millom and Askam Hematite Iron Company's works, and the other on basic iron by Dorman, Long and Co. The furnace put out of commission belonged to the New Cransley Iron and Steel Company, in Northamptonshire. The production of pig iron in September amounted to 359,700 tons, compared with 362,700 tons in August (a slightly increased daily rate), and 260,400 tons in September, 1932. The production includes 118,400 tons of hematite, 150,600 tons of basic, 75,200 tons of foundry, and 8100 tons of forge pig iron. The output of steel ingots and castings in September amounted to 669,000 tons, compared with 551,300 tons in August and 430,300 tons in September, 1932.

Pig Iron.

The slight irregularity in trading which is noticeable in the pig iron market is principally due to the circumstance that most users are covered for some time ahead. In some cases they have bought for delivery well into next year. For the time being, therefore, dealings are chiefly confined to small parcels; but users show little inclination to delay placing even small orders as they are evidently nervous regarding the possibility of an increase in prices. There is, however, a difference of opinion as to the likelihood of prices being raised except in the case of hematite. Although production costs have advanced stocks in several districts are still heavy, and any substantial upward movement might be followed by an increase in the importation of foreign iron. The quantities of Indian basic and foundry iron imported are regulated by an agreement between the British and Indian producers; but heavy stocks of foundry and basic exist on the Continent, and there is little doubt that the holders would welcome an opportunity of disposing of some of these accumulations at cheap prices in the British market. Perhaps the most favourably situated district in this country is the North-East Coast. The production of Cleveland iron is still limited to two furnaces, and, according to all accounts, little unsold iron is left in the makers' hands. Lately there have been hints that the stocks have not been reduced to the extent reported, and it is a pity that the producers cannot see their way to issue a statement on the position. One argument used against the view that stocks have been dispersed is that the makers continue to quote for export at much below their official home prices. It is intended to start up another furnace towards the end of the month at Dorman, Long and Co.'s Cleveland works. There is a prospect also that some of the coke batteries on the North-East Coast will be restarted and ironstone mines reopened. In the Midlands buying does not seem to be quite so brisk as of late, but the demand is said to be equal, if not in excess of, production. Hematite prices are steadily strengthening and have advanced to £3 0s. 6d. for No. 1, and £3 for mixed numbers.

Semi-finished Steel.

An interesting situation is developing in the market for semi-finished steel materials. The excellent position in which the British producers of billets and sheet bars find themselves, owing to the diversion of orders from the Continent as a result of the application of import duties, is leading to a gradual stiffening in price. Many consumers have entered into arrangements with suppliers, the most outstanding instance being that between the Whitehead Iron and Steel Company, Ltd., and Richard Thomas and Co., Ltd., by which the latter supply the former with the necessary raw material from their Redbourn Hill Works. In some respects it is unfortunate that the figures of production for this class of material are not obtainable, as they would probably disclose a very large increase in output during the last few months. Many of the makers are unable to give delivery before the end of the year, whilst others are asking premiums of from 5s. to 7s. 6d. One of the results of these rather tight conditions is that somewhat heavier purchases of Continental semis have taken place during the past few weeks than for several months. Sellers of this material claim that where it is required for special purposes they have been able to obtain higher prices than those asked by the British makers; but that for ordinary work the prices quoted have been subject to negotiation and have been well below the British price after the duties have been paid. It will be interesting to see if the trade in Continental semis will continue to increase, although, of course, it can never reach the proportions of pre-duty days. A comparison of the tonnage imported to the end of September this year with the imports for the corresponding periods of previous years is interesting. In 1931 the total for the nine months was 825,546 tons; in 1932 it fell to 633,253 tons, and in this it is down to 220,638 tons.

Finished Steel.

Although some departments of the finished steel branch of the industry have become less active during the past week or two, on the whole the gains have exceeded the losses. The completion of the Argentine orders for galvanised sheets has left the makers short of work, and they are pressing for new business. The demand for boiler plates also remains at a disappointing level, whilst most branches of the trade dependent upon shipbuilding are feeling the ill-effects of the slump in this department. On the other hand, the production of plates, ⅛in. and over, has been on a good scale, the figures for the past few months showing a substantial increase over the average monthly rate for the last two years. The output of sections, girders, and joists also is considerably in excess of the averages for 1931 and 1932, the figure for last July being 128,400 tons, and it is probable that this rate was maintained in August and September. On the North-East Coast steel is being produced at the rate of over 100,000 tons per month, and there seems a likelihood that this rate will be increased. The constructional engineering shops in this district are well off for work, and a fair amount of business in the way of orders for rails is also in hand. In the Midlands there has been some falling off in the demand for finished steel, some of the structural engineering companies having worked off several fair-sized contracts to replace which fresh orders are required. On the other hand, business in black sheets has expanded. The Midland re-rollers also are well employed on contracts for steel bars booked a few weeks ago, but at the moment there is not a great deal of new business passing. Some transactions in Continental material have been heard of, but considering that the price of the British small bars is now £6 17s. 6d., whilst the Continent continues to quote in the neighbourhood of £6 10s., it is almost surprising that more orders are not going abroad.

Scotland and the North.

Steady, rather than active, conditions have ruled in the Scottish market for the past fortnight. The production of finished steel is below capacity, but this year there have been one or two intervals of quietness which have been followed by an increased demand. The placing of an order on the Clyde for a naval sloop of 1500 tons will provide some business for the steel makers, although there seems no immediate likelihood of the shipbuilding industry escaping from the depression which has affected it for so long. William Beardmore and Co., Ltd., have booked an order for forgings which will be used in the construction of Imperial Chemical Industries' new plant for extracting oil from coal. The Scottish re-rollers are not so busy as the English branch of the industry. They have maintained their price for home delivery at £7 5s. and £6 15s. for export, f.o.b. Glasgow. Continental sellers quote similar material at much less and are taking a certain amount of business. In the Lancashire market there is a fair demand for constructional steel, but it is made up of small orders. The demand for special alloy products, however, and for bright steel bars continues active, and business in strip remains on a good scale. For the moment the volume of inquiry has fallen off, but it is regarded as only a temporary lull. The works on the North-West Coast have resumed operations after the stoppage of a week at Workington. They are principally engaged upon rolling railway material, whilst at Barrow the finishing departments are producing bars and hoops. In South Wales new business in tin-plates has been rather quieter, but this is not an unusual feature at this season, and the works are well employed, operating at about 66 per cent. of capacity. Even in this comparatively dull period orders are coming to hand sufficient almost to equal those which are being completed.

Copper and Tin.

A feature of the copper market this week has been the resistance shown to the depressing effects of the international political crisis. This market is usually over-sensitive if anything to outside influences, and the fact that prices have been firm rather than weak indicates that the undertone of the market is sound. The fall in values which took place last week had, of course, made the metal undeniably cheap, and there may have been a certain amount of buying by Continental interests who fancied copper as a safe lock-up in difficult times. Buying for industrial purposes has been poor, and consumers seem determined to adhere to their policy of covering only for their immediate requirements. Business in manufactured copper materials has not been good, and this, combined with the recent weak tendency of prices of the raw metal, has no doubt encouraged consumers to postpone purchases as long as possible. Prices in the London standard market have shown a tendency to move in sympathy with the electrolytic quotations. The stocks of copper are decreasing, and although some metal has been imported from the Continent, the tonnage is not sufficient to make up for the withdrawals from warehouse. . . . The tin market also has not been greatly influenced by the unfavourable political situation. The slight reaction in prices which occurred early in the week was short-lived, and a firmer tone afterwards developed. Most of the bull accounts in this market seem to have been liquidated, but whenever prices have looked like receding support has been forthcoming from powerful interests which, not unnaturally, the market assumes to be connected with the Pool. Buying from the United States and the Continent has been light, and the South Wales tin-plate makers have not shown much interest in the market. Statistically, however, the position appears to be gathering strength and a decline of as much as 3000 tons is anticipated in the visible supply at the end of October.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 0 0	3 0 0
No. 1	3 0 6	3 0 6
Cleveland—	*(D/d Teesside Area)*	
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
Midlands—		
Staffs.—	*(Delivered to Black Country Station)*	
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/9 to 17/–.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	5 15 0
„ Medium (0·42% to 0·60% C.)	6 12 6
„ Hard (0·61% to 0·85% C.)	7 2 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 25% C.), 500 tons and up	5 2 6
100 tons	5 10 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/7 per lb.	
Ferro Tungsten	2/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 17 6	7/–
„ „ 6 p.c. to 8 p.c.	£19 7 6	7/–
„ „ 8 p.c. to 10 p.c.	£18 17 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£29 15 0	9/–
„ „ „ 1 p.c. carbon	£30 17 6	10/–
„ „ „ 0·70 p.c. carbon	£35 5 0	12/6
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£18 2 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, October 18th.

Copper—		
Cash	£33 3 9 to £33 5 0	
Three months	£33 7 6 to £33 8 9	
Electrolytic	£36 10 0 to £37 5 0	
Best Selected Ingots, d/d Birmingham	£37 5 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10¼d.	10¼d.
„ Brazed (basis)	10¼d.	10¼d.
Brass—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£224 0 0 to £224 2 6	
Three months	£223 17 6 to £224 0 0	
Lead:	£11 13 9 to £12 0 0	
Spelter:	£16 6 3 to £16 11 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 13/–
„ Glasgow— Ell	12/6 to 14/–
„ „ Splint	14/6 to 14/9
Ayrshire—	
(f.o.b. Ports)—Steam	11/6 to 11/9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/– to 14/–
Unscreened Navigation	12/3 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	12/– to 12/6
Secondary Steam	11/6

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
Northumberland—	
Best Steams	13/9 to 14/–
Second Steams	12/6 to 13/–
Steam Smalls	8/6
Unscreened	11/6 to 12/6
Durham—	
Best Gas	14/6
Foundry Coke	17/– to 18/6

Sheffield—	Inland.	
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	8/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	17/9 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	19/– to 36/–
Furnace Coke	15/– to 17/6
Patent Fuel	20/–
Swansea—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	10/– to 11/–
Steam Coals:	
Large	18/– to 20/6
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	3¾d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Engineers and Architects.

In the designing of residential buildings the architect was formerly able to follow more or less orthodox lines and prepare his plans and execute them with the certainty that they would not be subjected to criticism. The last decade has witnessed an entire change in the character of those buildings, which must be designed with a view to "modern comfort," comprising bathrooms, central heating, and electrical equipment, and the scientific application of hygienic principles has introduced factors of lighting and insulation from heat and cold, while new building materials have necessitated far more care and supervision than in the days when houses were built of stone. The profession of the architect therefore encroaches upon the domain of the engineer, and even if he were able to acquire a full knowledge of all these new factors in building, the architect would still find it difficult to survey everything and guarantee that the work will be permanently satisfactory. The architect has to rely upon the contractor and upon the suppliers of installations and fittings. It is complained that his specifications are not sufficiently detailed, and that the wide range of tenders for the work can only be explained by different interpretations of the specifications, with the result that the lowest tenders are not necessarily the cheapest. It is therefore suggested that architects should have the assistance of engineers, who will prepare specifications, particularly with regard to heating, electrical, and other apartment fittings which must provide for future developments in the way of domestic utilisation. The engineers would also survey the execution of the mechanical and electrical work instead of leaving it to the contractor. The engineer would provide a guarantee of security.

The Forty Hours' Week.

A condition attached to the programme of public works is that the forty hours' working week will be imposed in all cases, and that it must be observed by firms supplying material purchased by the State for those undertakings. This stipulation is naturally causing a good deal of uneasiness amongst manufacturers, who can hardly employ men specially on such orders without making the observance of the forty hours' week general in the shops where the work is being executed. Manufacturers are unanimous in their objection to follow the Government in its policy to secure international recognition of the short week, and while the effects on costs produced by the forty hours' week without wages reduction are supposed to fall equally on makers in all countries if the system is adopted internationally, it cannot be applied solely to France without putting industry entirely out of the running in competition for world trade. Already industry in this country is so heavily burdened by taxation and social charges that manufacturers insist upon immediate relief in order to avoid succumbing to the tide of rising costs. They fear that the stipulation proposed to be attached to orders for public relief works will be the thin end of the wedge which will eventually make the forty hours' week more general.

Conservatoire des Arts et Metiers.

In view of the increasing number of students applying for admission to the Conservatoire des Arts et Métiers it was found necessary to provide additional accommodation, which offered difficulties because the building cannot be extended in area or in height. The school forms part of the Priory of Saint-Martin-des-Champs, which was built in the eleventh century, and the Conservatoire des Arts et Métiers was installed in it at the time of the French Revolution. The only way of providing new class rooms was to build them under the courtyard, which has, on one side, the part of the Priory used as a library, and the work had to be carried out without risk of weakening the foundations of that historic building. Concrete piers were constructed underground and upon them was laid a reinforced concrete platform, after which the excavation was continued to a depth of 18 m. and three lecture halls were constructed, providing a total accommodation for 1300 students. The work has now been completed, and the underground lecture halls will be inaugurated shortly by the President of the Republic.

The Vosges Tunnel.

Eight months ago work was started upon the tunnel through the Vosges between Saint-Maurice and Wisserling in order to connect up the Est and Alsace-Lorraine railways and shorten the distance between Calais and Switzerland by 32½ miles. The time thus employed included that spent on preliminary works, and tunnelling has so far only advanced 500 m. Operations are seriously retarded by the number of springs that are being tapped, producing at times as much as 1800 litres per minute. Arrangements will have to be made to drain off permanently what is likely to be a large volume of water. The length of the tunnel will be 5¼ miles, the width 9·5 m., and the height above the permanent way 6·1 m. It will have a constant gradient of 8 mm. per metre. Owing to the difficulties encountered it is expected that it will take five years to complete the undertaking.

The Steel Cartel.

The working of the International Steel Union was dependent on the Belgian group being able to secure the support of the Forges et Clabecq, which had persistently held aloof from the negotiations and finally consented to join up temporarily with a view to seeing whether the operations of the Cartel would be favourable to its interests. At the recent annual meeting of the Forges et Clabecq the managing director stated that the company was dissatisfied with the result of its participation in the work of the Union and that, unless the situation improved, it would be obliged to withdraw from the Cartel at the end of the year.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

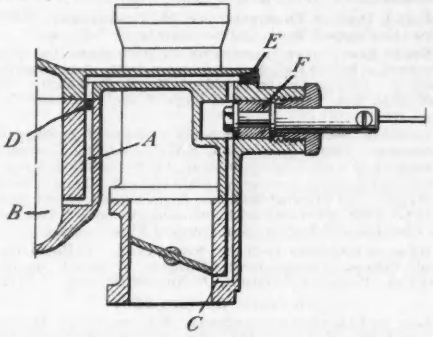
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

397,991. June 4th, 1932.—Carburetters, C. H. L. Wynne, E. W. Knott, and A. C. Miller, of Bendix-Perrot Brakes, Ltd., King's-road, Tyseley, Birmingham.

The object of this invention is to facilitate the starting up of a petrol engine by supplying it, for the time being, with a comparatively rich mixture. A passage A leads from the float chamber B of the carburetter to the port C on the engine side of the throttle valve. In this passage there is arranged an orifice D, which is of such a size that it will pass sufficient petrol to run the engine at a speed slightly in excess of its normal idling speed until it is warmed up enough to take up the load. There is also an opening to atmosphere at E, through which air is sucked to gasify the fuel. A piston valve F is provided to shut off the passage. For starting up the throttle is closed and the piston valve opened, and when the engine is running properly the piston valve is closed.—*September 7th*, 1933.

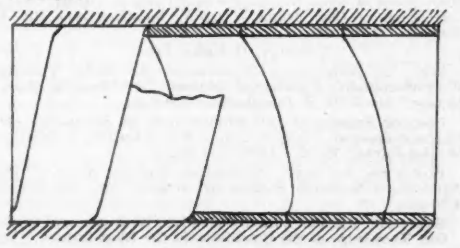
Nº 397,991



398,009. July 18th, 1932.—Cylinder Liners, Gebr. Lüttges, Kom. Ges. (sole responsible partner Gustav Lüttges), Solingen, Rheinland, Germany.

The inventor explains, at considerable length, the troubles which may be experienced when the cylinder of an internal combustion engine is provided with a rolled steel liner, and goes on to claim that these troubles will be overcome if the liner is formed as a helix, as shown in the drawing. It is inserted in the cylinder bore with a twisting action, so that when it is released it expands tightly against the bore.—*September 7th*, 1933.

Nº 398,009

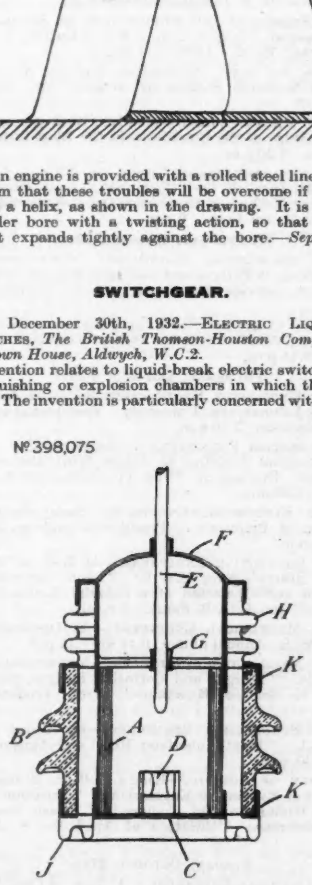


SWITCHGEAR.

398,075. December 30th, 1932.—Electric Liquid-break Switches, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, W.C.2.*

The invention relates to liquid-break electric switches having arc-extinguishing or explosion chambers in which the contacts separate. The invention is particularly concerned with explosion chamber switches in which the chamber also forms a container for the liquid, and is installed in the open, and is, consequently, subjected to the influences of the atmosphere. The extinguishing chamber consists of an inner cylinder A of hard paper and a ceramic outer insulator B of the customary ribbed type. The bottom C carries the fixed contact D, whilst the movable contact rod E is guided by the hood F on which a fixed contact G may be provided. Both the bottom C and the hood F are rigidly connected with the insulating body A. The pressure set up on switching is taken up exclusively by the internal insulator A. The external insulator B is connected with the switching chamber at its upper end by means of the elastic corrugated tube H through the hood F, which may, if necessary, be elastic. The lower connection J of the external insulator with the switching chamber may also be elastic. The connections should preferably be such as to exclude atmospheric changes from affecting the space between the two insulators. With a view to easier mounting and interchangeability, the elastic intermediate element H or J may be disengageably connected to flanged rings K cemented to the insulator B, whilst it has a welded or soldered connection at its other end. The extinguishing chamber may be filled either with a conducting liquid, such as water, or with an insulating liquid, such as oil.—*September 7th*, 1933.

Nº 398,075



TRANSFORMERS AND CONVERTERS.

397,856. November 21st, 1931.—Transformers of the Static Type, Hugh Godfrey Nicholson, of Britannia Works, Colchester.

The main object of this invention is to provide a transformer, the secondary voltage of which will keep constant or will increase at a predetermined rate with increasing lead current. As shown in Fig. 1, a laminated magnetic circuit A links the turns of the primary B, but not the turns of the secondary C, the auxiliary magnetic being outside the window D of the transformer. Additional control may be obtained by the addition of a coil E connected in series with a variable condenser F, as shown in Fig. 2. Another alternative scheme is described and the theory is explained in each case.—*August 21st*, 1933.

Nº 397,856

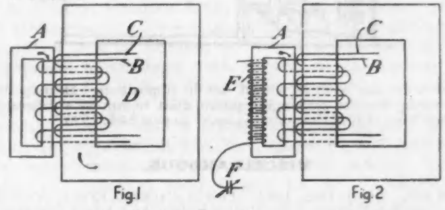


Fig. 1 Fig. 2

397,953. April 6th, 1932.—Protective Arrangements for Electric Power Transformers, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2: and Charles Cornfield Garrard, of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

A protective arrangement for an electric power transformer, according to this invention, comprises a switch or circuit breaker with or without fuses on one side of the transformer, a switch fuse on the other side of the transformer and a removable mechanical operating or interlock device which must be positioned relatively to the switch or circuit breaker before the latter can be closed and relatively to the switch fuse before the latter can be opened. Means are also provided for preventing removal of the device from the switch or circuit breaker unless the latter is open and means for preventing removal of the device from the switch fuse unless the latter is closed. The transformer is provided with a high-tension winding delta connected to the three phases of the supply through individual phase switch fuses A. The low-tension side of the transformer is delta connected through a circuit breaker B to the low-tension lines. Referring now to Fig. 2, the three switch fuses are provided with a common operating spindle C extending through the wall of the switch fuse enclosure D. The spindle C is formed with a square head for a removable operating handle E provided with an axial extension piece F. If the operating handle is moved to the "off" position, wherein the switch fuses are opened, the extension piece F moves between a lug G mounted on the wall of the enclosure D and the wall itself, and accordingly prevents removal of the operating handle E, which can therefore only be removed when it is in the "on" position, *i.e.*, when the switch fuses A are closed. The low-tension circuit breaker B is also provided with a common operating shaft H—Fig. 3—which extends through the wall of the circuit breaker enclosure J and is formed with a square head which is adapted to be engaged by the operating handle E. In this case it is arranged that when the operating handle is in the "on" position, *i.e.*, the circuit breakers are closed, the axial extension K of the operating handle is between a lug L formed or mounted on the wall of the enclosure J and the wall, so that the operating handle cannot be removed when the low-tension circuit breaker B is in the closed position, but only when the breaker is open. Since only one handle E is provided for the operation of both the high-tension switch fuses A and the low-tension circuit breaker B, the switch fuses can be opened or closed only when the circuit breaker B is open.—*September 7th*, 1933.

Nº 397,953

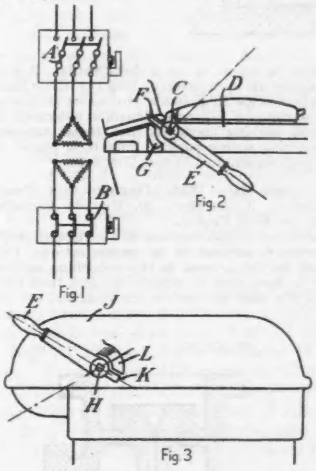


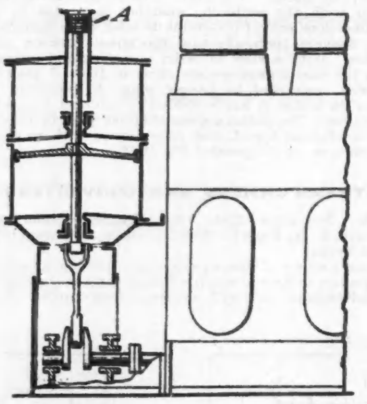
Fig. 2 Fig. 1 Fig. 3

TRANSMISSION OF POWER.

397,387. February 14th, 1933.—Balancing Reciprocating Engines, Sulzer Freres Société Anonyme, Winterthur, Switzerland.

Cyclic variations in the speed of the crank shaft of, for instance, a multi-cylinder oil engine are, according to this invention, minimised by placing a weight A on an extension of the scavenging pump piston rod. The pump crank is then set in such a position that the impulses from the working cylinders and from the balance weight act in opposition. It may be necessary for the scavenging pump shaft to run at a different speed from that of the main engine.—*August 24th*, 1933.

No. 397,387

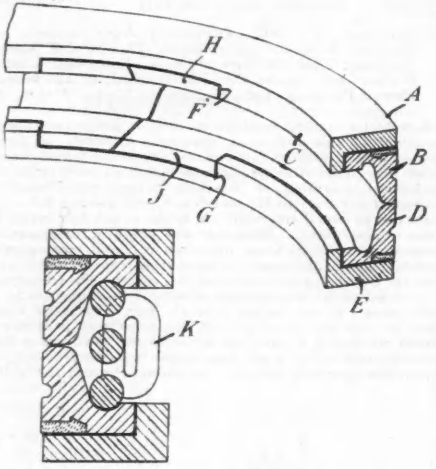


MISCELLANEOUS.

396,854. March 18th, 1932.—Piston Packing Rings, Wilfred Stephen Carlisle, John Robert Kelsey, and Albert Corbidge, all of Eagle Foundry, Stalker Lees-road, Sheffield.

The piston ring comprises a complete or undivided ring A of similar diameter to the packing rings B, D, and having a flange or lip C on its inner side, which is placed over the packing ring B with its flange or lip C downwards. A similar ring E is placed under the lower packing ring D with its flange upwards. Each of these rings A, E has a portion of its lip or flange cut away, as shown at F, G, and a segmental extension H, J on each of the split packing rings fits into these cut-away portions. A double-acting spring packing ring K is placed between the two split packing rings.—*August 17th*, 1933.

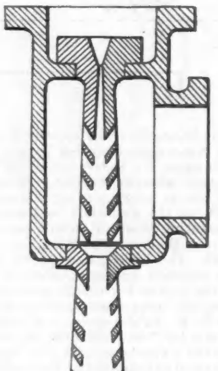
No. 396,854



397,992. June 7th, 1932.—Devices for Propelling by Reaction, J. A. Rey, 30, Rue de Versailles, Viroflay (Seine-et-Oise), France.

This invention is put forward as a means of propelling ships, road vehicles, or aircraft by an ejector action. It is suggested that steam should be used as the propelling medium and that it should be first used to entrain air and then the mixture of steam and air used to entrain, for instance, sea water for the propulsion of a ship. In which case it is said, the boiler may be fed with sea water. The inventor gives some calculations to substantiate the efficacy of his arrangement and insists that it must comprise " a duct for the passage of propelling fluid having an enlarging taper formed from a single body of material and provided with a succession of ports for the progressive entrainment of additional fluid by injector action, the outlet being of substantially constant cross section so as to maintain constant the speed of the issuing fluids."—*September 7th*, 1933.

No. 397,992



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.

To-day.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting; election of Sub-committee. Discussion, "The Horse-power of Locomotives," introduced by Mr. A. G. Hopkins. 7 p.m.

Inst. of Sanitary Engineers.—At Caxton Hall, Westminster, S.W.1. "Aggregates for Concrete Work," Dr. Bernard H. Knight. 6 p.m.

Inst. of Structural Engineers: Scottish.—129, Bath-street, Glasgow. Chairman's address, Professor Sir Thomas Hudson Beare. 7.30 p.m.

Inst. of Structural Engineers: Western Counties.—Merchant Venturers' Technical College, Unity-street, Bristol. "Foundations," Mr. G. B. R. Pimm. 7.15 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "Air Lift Pumps," Mr. A. C. Judd (member). 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. Annual general meeting. Address by the President, Mr. R. J. Walker; cinematograph film, "Mechanism of Ships' Wake,' Professor T. B. Abell.

Physical Society.—At Imperial College of Science and Technology, South Kensington, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 5 p.m.

Soc. of Chemical Industry (Food Group).—London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, W.C.1. Joint discussion with Physiological Soc., "Diet from the Chemical and Physiological Points of View." 8 p.m.

West of Scotland Iron and Steel Inst.—At Royal Technical College, George-street, Glasgow. Council meeting, 6.45 p.m. Presidential address, Dr. Andrew McCance. 7.15 p.m.

Saturday, October 21st.

Inst. of Electrical Engineers: N.E. Students' Section.—Visit to Messrs. A. Reyrolle and Co.'s short-circuit test plant, Hebburn. 2.30 p.m.

Inst. of Electrical Engineers: North Midland Students.—Visit to works, A. Kershaw and Sons, Ltd., Harehills-lane, Leeds. Meet G.P.O., City-square, Leeds, 2.30 p.m.

Inst. of Electrical Engineers: S. Midland Students.—Afternoon visit to *Birmingham Gazette*, Ltd., offices, Corporation-street, Birmingham.

Inst. of Mechanical Engineers: Graduates.—Visit to the de Havilland Aircraft Company, Stag-lane Aerodrome, Edgware.

N. of England Inst. of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. Presidential address, Mr. W. R. Glass. Paper, "Microstructure of the Coal of Certain Fossil Tree Barks," Professor G. Hickling and Mr. C. E. Marshall. Discussions: "Impoverished Areas of the Maudlin and Busty Seams in the Durham Coalfield," Dr. William Hopkins; "The Microspores of some Northumberland Coals and their Use in Correlation of Coal Seams," Dr. A. Raistrick and Mr. J. Simpson. 2.30 p.m.

Tuesday, October 24th.

Inst. of Automobile Engineers.—At Hotel Victoria, Wolverhampton. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow, C.2. "Flame Cutting of Steel for Welded Joints," Mr. E. J. Clarke. 7.30 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "The Agricultural Research Station at Amani," Mr. W. Nowell. 4.30 p.m.

Sheffield Metallurgical Soc.—198, West-street, Sheffield. "Our Knowledge of the Conditions in the Blast-furnace," Mr. R. C. Tucker. 7.30 p.m.

Societe des Ingenieurs Civils de France: British Section.—At Inst. of Civil Engineers, Great George-street, S.W.1. "New Methods of Excavating Quicksands and Unstable Ground," Sir Henry Japp. 6 p.m.

Wednesday, October 25th.

Inst. of Mechanical Engineers: Yorkshire.—Grand Hotel, Sheffield. "Fatigue and Corrosion Fatigue, with Special Reference to Service Breakages," Prof. Frederic Bacon. 7.30 p.m.

North-East Coast Inst. of Engineers and Shipbuilders: Graduate Section.—"Electric Cargo Winches," Mr. C. E. Clouston. 7.15 p.m.

Thursday, October 26th.

Glasgow University Engineering Soc.—At James Watt Engineering Laboratories, University. Presidential address by Mr. H. A. Reincke. 7.30 p.m.

Inst. of British Foundrymen.—Joint meeting with Midland Metallurgical Societies at James Watt Memorial Inst., Birmingham. Discussion, "The Production of Sound Iron Castings." 7.30 p.m.

Inst. of Electrical Engineers.—Savoy-place, W.C.2. Presentation of Premiums. Presidential address, Mr. P. V. Hunter. 6 p.m.

Inst. of Locomotive Engineers.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Some Aspects of the Organisation and Operation of a Colonial Railway Running Department," Mr. J. G. B. Sams. 6 p.m.

Inst. of Mechanical Engineers.—At Dorchester Hotel, Park-lane, W.1. Annual dinner, 6.45 for 7.15 p.m.

Inst. of Mechanical Engineers: Yorkshire.—Queen's Hotel, Leeds. "Fatigue and Corrosion Fatigue, with Special Reference to Service Breakages," Prof. Frederic Bacon. 7.30 p.m.

Inst. of Structural Engineers.—10, Upper Belgrave-street, S.W.1. "The Cumberland Hotel and Annexe," Mr. A. Frost. 6. 30 p.m.

University of London.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: ii., Basic Problems—Cycle of Reference—Utilisation of Air," Dr. S. J. Davies. 5.30 p.m.

Friday, October 27th.

Inst. of Chemical Engineers.—At Inst. of Civil Engineers, Great George-street, S.W.1. "Engineering in the Service of Chemical Research," Professor G. T. Morgan. 6.30 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. General meeting. Presidential address, Mr. Alan E. L. Chorlton. 6 p.m.

Inst. of Structural Engineers: Midlands.—James Watt Memorial Inst., Birmingham. Chairman's address, Mr. E. L. Cotterell. 6.30 p.m.

Inst. of Electrical Engineers: N.E. Centre Students.—At Armstrong College, Newcastle-upon-Tyne. "The Dunston 50-cycle Power Station," Mr. A. S. Carr. 7.15 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "The Electrolytic Theory of Corrosion," Mr. H. E. Yerbury, M. Inst. C.E., M.I. Mech. E., M.I.E.E. 7.30 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse, Mr. E. V. Appleton. 9 p.m.

Saturday, October 28th.

Hull Assoc. of Engineers.—Municipal Technical College, Park-street, Hull. "Experimental Research on Boundary Lubrication," Mr. J. E. Southcombe. 7.30 p.m.

Inst. of British Foundrymen.—The Technical College, Derby. "Technical Control in the Small Foundry," Mr. J. G. Pearce. 6 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. "The Course and Causes of the World Depression," Mr. L. C. Robbins. 3 p.m.

Stephenson Locomotive Society.—Visit to Stratford, L.N.E. Railway Running Sheds. 2.30 p.m.

Monday, October 30th.

Bradford Engineering Soc.—Technical College, Bradford. "Salvage Work on the Ex-German Fleet at Scapa Flow," Mr. E. F. Cox. 7.30 p.m.

Inst. of Automobile Engineers.—At 39, Elmbank-crescent, Glasgow. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Stainless Steels in Aeroplane Structures," Mr. F. J. Murdoch. 6.45 p.m.

Tuesday, October 31st.

Inst. of Transport.—At Inst. of Electrical Engineers, Victoria Embankment, W.C.2. Discussion, "The Duties of a Modern Transport Manager," Mr. M. F. Barnard.

Wednesday, November 1st.

Inst. of British Foundrymen.—At Charing Cross Hotel, London, W.C.2. "Cupola Practice," Mr. L. W. Bolton. 8 p.m.

Inst. of British Foundrymen.—Technical College, Corporation-street, Preston. "Manufacture and Application of Centrifugal Castings," Mr. T. R. Twigger. 7.30 p.m.

Inst. of Physics.—In the Royal Institution, 21, Albemarle-street, W.1. "Physics in the Building Industry," Dr. R. E. Stradling. 5.30 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. Presentation of medals. Address, "Quality," Mr. John A. Milne. 8.30 p.m.

Thursday, November 2nd.

Inst. of Automobile Engineers.—Queen's Hotel, Birmingham. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 8 p.m.

Inst. of British Foundrymen.—At James Watt Memorial Inst., Birmingham. "The Education of Foundry Workers," Professor J. H. Andrew. 7.30 p.m.

University of London.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: iii., Injection: Processes in Injection Systems," Dr. S. J. Davies. 5.30 p.m.

Friday, November 3rd.

Faraday House Old Students' Assoc.—At Savoy Hotel, W.C.2. Twenty-fifth annual dinner.

Inst. of British Foundrymen.—Municipal College, Ormerod-road, Burnley. "Continuous Casting Plant," Mr. F. J. Cook. 7.15 p.m.

Inst. of Marine Engineers.—Grosvenor House, Park-lane, W.1. Annual conversazione. 7 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Thomas Hawksley Lecture, "Kinematic Design in Engineering," Professor A. F. C. Pollard. 6 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Safety and Efficiency in Electrical Installation Work," Mr. W. F. C. Cooper. 7.30 p.m.

Railway Club.—57, Fetter-lane, E.C.4. "Train Ferries: Their History and Development," Mr. S. R. Yates. 7.30 p.m.

Saturday, November 4th.

Inst. of British Foundrymen.—At Engineers' Club, Manchester. "Continuous Casting Plant," Mr. F. J. Cook. 4 p.m.

Inst. of Electrical Engineers: North Midland Students.—Visit to the Hunslet Engine Company, Ltd., Jack-lane, Leeds. Meet at Corn Exchange, Leeds, 2.30 p.m.

Tuesday and Wednesday, November 7th and 8th.

Inst. of Gas Engineers.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Fifth autumn research meeting. Morning sessions, 10 a.m.; afternoon sessions, 2.30 p.m.

Thursday, November 9th.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. Junior Section. "Pumps for Marine Service," Mr. F. M. Jones. 7 p.m.

Inst. of Structural Engineers: Yorkshire.—Hotel Metropole, Leeds. "Designing for Welding," Mr. C. Helsby. 7 p.m.

University of London.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: iv., Injection: Processes in the Cylinder," Dr. S. J. Davies. 5.30 p.m.

Friday, November 10th.

Inst. of British Foundrymen.—At the Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. "Routine Methods of Testing Green Sands," Mr. N. D. Ridsdale. 7.45 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Discussion, "Financing Industry," introduced by Mr. Sydney Parkes. 7 p.m.

Saturday, November 11th.

Inst. of British Foundrymen.—Technical College, Monks-road, Lincoln. "Use of Refractory Materials in the Foundry," Dr. J. G. A. Skerl. 7 p.m.

Inst. of Marine Engineers: Junior Section.—85–88, The Minories, E.C.3. Social and dance. 7.30 p.m.–11.15 p.m.

Monday, November 13th, to Saturday, November 18th.

Public Works Congress and Exhibition.—Agricultural Hall, Islington, N.1. Daily. (For programme see page 365).

Tuesday, November 14th.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. "Welding for Pressure Vessels," Mr. R. Sulzer. 6 p.m.

Thursday, November 16th.

British Waterworks Assoc.—Agricultural Hall, Islington, N.1. To receive and discuss the following papers:—"Pooling of Supplies by Interconnection of Water Undertakings and their Trunk Mains through Rural Areas," Mr. Alan E. L. Chorlton; "Water Pollution Research," Dr. A. Parker. 11 a.m. Afternoon session: "The Financial Management of Municipal Trading Departments," Mr. Sydney Larkin; "Water Supply and Fire Protection," Mr. John Smith; "Fire Prevention and Fire Extinguishing Apparatus," Major F. W. Jackson; "The Legal Aspect of Water Supply for Fire Protection Purposes," Mr. John Hall. 2.45 p.m.

A Seven-Day Journal

The Prevention of Fires Aboard Ship.

At a meeting of the Society of Consulting Engineers and Surveyors, held on Wednesday, October 18th, in the Library of Lloyd's under the chairmanship of Sir Percy Mackinnon, Mr. Arthur T. Woods, director of Royal Mail Lines, Ltd., read a paper in which he gave a number of practical suggestions for the prevention and control of possible fires at sea. While paying tribute to the adequacy of the present Board of Trade regulations, Mr. Woods strongly advocated the patrol system and the organisation of trained fire-fighting units, alike for voyage and port service. Referring to alleyways and corridors, Mr. Woods suggested further isolation measures by the introduction of fire-resisting doors at suitable points, along with fire-resisting baffles. These, he suggested, might be constructed of metal, and in all cases fire-resisting paint should be employed. Such measures, he said, would break up the air flow and retard the spread of fire. He advocated the further decentralisation and individual control of forced ventilation circuits, and the use of steam, where possible, for fire extinguishing purposes. Sprinklers, he suggested, should be connected with the electric bell system in the cabins so that when they operated an alarm was at once given. Reference was also made to the "emulsion" system of putting out oil fuel fires, and in general the desirability of a more extended use of impregnated timber and reliable non-inflammable paint for constructional woodwork and decorative fittings.

The West Middlesex Sewerage Scheme.

Some account of the scheme for co-ordinating the sewerage of West Middlesex, a civil engineering work of major importance, was given by Mr. J. D. Watson at the meeting of the Royal Sanitary Institute, which was held in Buckingham Palace-road on October 17th, under the presidency of Dr. George F. Buchan. Our readers will probably remember the outline of this scheme which we gave in The Engineer of March 17th, 1933. It involves the expenditure of some six millions sterling and the preliminary work has been completed. In his paper Mr. Watson told the story of the scheme, and how, when it was found that the increase in the population of the district—an area of some 160 square miles—had developed beyond all previous ideas, it became obvious that the natural drainage of the district could not cope with the increasing discharge of sewage effluent without the native streams becoming objectionable. The alternative of collecting the sewerage and the storm water from all the score of districts concerned, and treating the mixture at a central plant, was considered at great length, and ultimately it was decided by the Middlesex County Council that a plant should be put down at Mogden and connected with the existing drainage system by a network of intercepting sewers ranging in diameter up to 12ft. 9in. and having a total length of 67 miles. These sewers, it is estimated, will ultimately discharge at the works 480 million gallons a day. This flow, some of which will have to be pumped up from low-level sewers, will be treated by the activated sludge process at Mogden and the clear water discharged into the Thames at Isleworth through two conduits, each 11ft. in diameter. The resultant sludge will be pumped up a rising main, about 7 miles long, to be digested at Perry Oaks and turned, if possible, to a useful purpose. A feature of the Perry Oaks site will be its complete isolation from the surrounding country, by means of a puddle wall carried down to the London clay, and a drainage system connected with the local sewer, so that there may be no possible contamination of the adjacent streams.

Electrical Development.

In his presidential address delivered before the Association of Supervising Electrical Engineers on Wednesday, October 18th, Mr. J. M. Kennedy said that returns showed that last month the production of electricity was 10·8 per cent. greater than in September, 1932. Over the first nine months of this year there was an advance of 8·2 per cent. compared with the corresponding period of 1932. Whereas ten years ago the coal used in producing electricity was only 50 per cent. of that used in gasworks, the amount consumed in the two cases was now practically equal. Referring to railway electrification, Mr. Kennedy said that, comparatively speaking, it was a much more productive line of capital development than that of constructing new roads. Electrification provided traffic managers with means of attracting traffic, for it gave greater speed, cleanliness, and general comfort. The economy of shorter trains at more frequent intervals and the general absence of smoke and smell and better timekeeping were other important advantages. Experience on the Southern Railway showed that a very great increase in traffic could result from electrification, and although anything like the same increase could not be expected on main lines, a regular half-hourly service of electric trains between such cities as London and Birmingham and Manchester would bring about a considerable increase in passenger traffic. Having regard to the national advantages of electrical development, engineers should aim at something in the nature of a five years' plan to electrify all towns and villages down to a minimum of 100 inhabitants and at connecting up at least 1,000,000 consumers a year, of whom at least 50 per cent. should be cooking electrically.

A Coal Burning Appliance Makers' Association.

At a meeting of representatives of engineering and industrial firms, held in London on Friday last, October 20th, a Coal Burning Appliance Makers' Association was formally constituted. Mr. Teeling Smith was elected the first Chairman, and a committee of eighteen members, representing the makers of industrial, marine, and domestic coal-burning appliances, was appointed. Mr. W. A. Lee, the Secretary of the Mining Association, said that the coal mining industry regarded the appliance makers as the spearhead of their effort to stimulate the consumption of solid fuel, and he welcomed the new Association because its co-operation was indispensable to the advancement of Britain's staple fuel. The new Association has been brought into being as a result of the initiative shown by the Coal Utilisation Council, which has realised from the first that the finest fuel would not give the best satisfaction or value if it was used with old-fashioned or indifferent appliances. The work of the new Association will include the standardisation of the terminology of coal-burning appliances and the establishment of agreed methods of stating comparative results and efficiency. It will co-operate with the Coal Utilisation Council in promoting the better marketing and distribution of definitely graded coal, and supplying useful information regarding developments in the utilisation of coal.

Shipbuilding and the North-East Coast.

In his presidential address delivered at the annual general meeting of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle-on-Tyne, on Friday evening, October 20th, Mr. R. J. Walker stated that he felt at the moment that it was safe to make the observation that there were signs of a general improvement in trade. The shipping industry was the first to be affected by any depression, and the last to benefit by any improvement, but recent official figures showed that the amount of laid-up shipping was less than what it was a year ago by some million and a quarter tons, while there were half a million more tons of shipping in commission to-day than a year ago. These facts seemed to indicate that we were now approaching brighter conditions. A revival in trade would, Mr. Walker continued, be a means of putting to the test the activities and initiative of our industries. Never in the history of the British shipbuilder and engineer had there been, he said, a time of greater necessity for putting forth in our work our very best endeavours in order to maintain our national reputation as the finest shipbuilders in the world, a reputation which had in no small degree been subscribed to by the work performed on the North-East Coast. That area, Mr. Walker continued, would, he was certain, as in the past, continue to play an important part in the production of tonnage which would help to win back the shipping prosperity of our country.

Iron and Steel Developments at Cardiff.

In a letter addressed by Sir John Beale, the chairman of British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd., to the Lord Mayor of Cardiff, last week, an extensive development scheme in connection with the works of the company at Cardiff was outlined. The new works will provide for the manufacture of about 300,000 tons a year of billets and sheet bars in the first instance, with provision for an increased output if the demand should warrant it. They will, it is expected, take about two years to build and equip, and will give direct and permanent employment to about 1500 men. By utilising a proportion of the existing plant molten iron from the blast-furnaces will be used in the manufacture of steel and the great natural advantages of the site further developed. It has been shown possible to produce at the proposed new works both billets and bars at a cost which should bear favourable comparison with other steel works and enable the output to be sold at a price satisfactory to users, which would, at the same time, give a reasonable return on the large capital outlay. The board has given instructions for the remodelling of a second blast-furnace and for a start to be made in clearing the site. The Lord Mayor of Cardiff has arranged for a deputation of the City Council to meet the company's directors at an early date.

Distribution.

In a Journal note of February 10th we dealt with the proposal to establish a British Distribution Committee in connection with the British National Committee of the International Chamber of Commerce. A step towards the establishment of this Committee has now been taken by the British National Committee, in collaboration with eight of the leading manufacturing firms, which have pledged themselves to contribute towards this work a minimum of £100 per year for three years or £50 for seven years. An appeal is now made for further support of a movement which is intended not to replace, but to supplement and extend, efforts now being made in specialised corners of the distributive field. The suggestion is made that the root cause of the present depression is the world's failure to distribute adequately the commodities which scientific method and modern technique can produce in superabundance. Costs of production, it is pointed out, have been steadily lowered for more than thirty years, whereas, on the other hand, costs of distribution have been rising, owing in a large measure to ignorance of the basic facts of the distributive process. The circumstances, it is held, demand urgently the formation of a British Distributive Committee, and all inquiries relating to the proposed Committee should be addressed to the Secretary of the British National Committee of the International Chamber of Commerce at 14, Queen Anne's-gate, London, S.W.1.

Forty-Hour Week Negotiations.

On Friday, October 20th, the joint committee of the trade unions of the engineering and shipbuilding industries met in London to hear replies from the employers' federations with regard to the unions' application for a forty-hour working week, without reduction in pay. The Shipbuilding Employers' Federation only sent a formal acknowledgment of the unions' application, but the Engineering and Allied Employers' National Federation wrote asking for further information with regard to the questions, first, as to how the proposed reduction of hours would reduce the present unemployment, or would create additional employment, and, secondly, how would the extra cost thereby involved, and the additional cost which would be incurred by increasing the hourly rate, be absorbed by the industry. It was decided not to answer these questions, but to write again to the Engineering Employers' Federation expressing the surprise of the unions at the new departure of opening correspondence on an important application when a request for a conference had been made. It was decided to remind the employers that in April last they stated that when the investigations then being made were completed, they would invite the unions to a conference to examine the problem of the industry's depression and consider what constructive steps might be taken for the betterment of the situation.

Accident to a Mail Plane.

It is now some years since the Air Ministry invited the aircraft manufacturers of this country to submit designs for a high-speed long-distance mail-carrying aeroplane. The general requirements laid down by the Ministry were that the machine should be capable of carrying 1000 lb. of mail and of flying non-stop for a distance of 1000 miles at a speed of 100 miles an hour. Several designs were submitted. In our issue of January 8th, 1932, we described and illustrated the type evolved by Saunders-Roe, Ltd. Another design produced by Spartan Aircraft, Ltd., was referred to in the same issue; while a third, the Boulton and Paul mail carrier, was illustrated in our issue of January 6th, 1933. We regret to learn that on Saturday, October 21st, the Boulton and Paul machine was completely wrecked while undergoing supplementary trials at Martlesham Heath. The machine had already been tested with satisfactory results by Flight Lieutenant Boothman, and on Saturday was being flown by Flight Lieutenant Richmond for the purpose of a further test, when, for some reason not at present disclosed, it crashed from a height of 1200ft. The machine was completely wrecked, and the pilot severely injured. It is understood that it had shown itself to be capable of carrying 1000 lb. of load for a distance of 1250 miles non-stop at a speed of 172 miles an hour, and to have a top speed of 195 miles an hour. It was fitted with two Bristol "Pegasus" engines of 575 horsepower each. It was of the biplane type, and not a monoplane, like the two other designs mentioned above.

A French Railway Disaster.

It is with regret that we have to record a serious French railway accident, which took place at 11.35 on Tuesday morning, when the Cherbourg–Paris express was passing over a viaduct between the stations of Conches and La Bonneville, near Evreux. The train, which it is estimated was travelling at a speed of about 65 miles per hour, was derailed, and the engine and tender with the guard's van and four carriages were precipitated over the viaduct into the river, which runs in a ravine some 30ft. below. Some thirty persons were killed and thirty-two injured. The first three coaches, which were of wood, were completely telescoped, and it was in them that the greatest loss of life took place. The last four coaches of the train remained intact. A preliminary inquiry was opened on the spot by the railway officials, and it is stated that no suspicion of foul play, which was rumoured in some quarters, could be found. It is thought, however, that as a gang of platelayers was shifting ballast near the scene of the accident, it may be probable that the rails were displaced as the train took the curve. No reason, however, can be given as to the cause of the accident until results of the official inquiry have been made known.

New Methods of Excavating Quicksands.*

By Sir HENRY JAPP, K.B.E., M. Inst. C.E., M. Soc. C.E. (France).

No. I.

Introduction.

In carrying out civil engineering works involving excavations for deep foundations, shafts or tunnels, engineers in all countries are confronted from time to time with what is commonly known amongst workmen as "bad ground." As the geological conditions are different in every continent, engineers have developed their individual methods, which vary in the distinctive national systems of timbering for trenches and tunnels.

The most difficult type of "bad ground" to be excavated generally consists of a fine wind-blown sand under water pressure called quicksand. Means more or less successful have been developed for dealing with such material, by relieving the pressure or holding back the water in such a way that the excavation can proceed without the quicksand boiling up and causing "blows," resulting in settlement and disturbance to the surrounding ground.

In excavating large areas for dock construction it is usual in water-bearing districts to sink sumps below the bottom of the work at strategic points, so that the water may be pumped and withdrawn from the subsoil. If the area is composed of open sand and gravel the volume of water is likely to be large, but there is no great difficulty in draining it providing sufficient pumping appliances are supplied. If, however, the material to be excavated is of a fine close sand, the water does not percolate freely to the sumps, and consequently many more sumps are required. The effect of pumping at a depth below the ground surface is to depress the water level near the sump. After pumping for some time it will be found that the level of the water in the ground rises from the bottom of the sump in the form of an inverted parabolic cone. In open sands the curve is flat, while in close sands the water curve rises steeply from the sumps, and unless the sumps are comparatively close together the inverted cones rising from adjacent sumps intersect above the bottom of the excavation, thus leaving the ground still under water pressure, resulting in the sand above the bottom of the excavation being unstable, and consequently "blows" occur.

In trenching nowadays it is usual to attempt to cut off the water by driving steel sheeting. In sinking deep shafts the freezing process has been successful in getting through beds of quicksand to the solid rock below. If the water head in the quicksand bed does not greatly exceed 100ft. it is possible to apply compressed air, so that the excavation of the shaft can proceed in the dry with entire safety. In tunnel driving compressed air is the most satisfactory method for overcoming difficulties in quicksand, the freezing process having proved quite unsatisfactory for this purpose.

In one case where a sump for draining a dock area had to be bottomed up through quicksand, in the writer's experience it was found, as the pumping and excavation proceeded, that the ground surface along with the timbering of the sump continued to sink. When it was seen to be impossible to sink the sump through the quicksand in the ordinary way, the pumping was stopped and the water allowed to rise; the last 8ft. of the sump was then sunk through the quicksand by divers. When the required depth was reached the divers formed a filter bottom to prevent the quicksand from coming in with the water, and the dock area was successfully drained without further settlement. In another case the same result was attained by means of compressed air for sinking the sump.

In cases where there is an underlying bed of dense water-bearing sands below the point of excavation under high water pressure the sinking of occasional sumps is not sufficient safeguard to prevent "blows," and this particular feature has always been a source of difficulty and danger. Until recently this situation has been met by the expensive process of sinking concrete monoliths by open dredging.

Recently there have been introduced to this country a new method which is proving of great benefit to civil engineering for dock excavations in cases of this kind.

This is the water-lowering process, by means of frequent wells of small diameter which reduce the water level.

Water-Lowering Process.

The method of draining open sandy soil by means of sumps is an old-established system, but the draining of fine close sandy soils under a head of water is impracticable by this method. The water-lowering process, however, consisting of small wells relatively close together, is a system that may be relied on under difficult conditions to solve this problem of draining dense sand successfully. This system was developed in Germany and the United States of America, and was introduced to this country only within the last few years. It originated in the step-wise system, which required that the excavation be done in lifts of some 16ft. to 18ft., or the depth that pumps could deal with reliably by suction. The initial step was to sink 3in. diameter vertical pipes about 40ft. apart along the line of the excavation. The pipes were perforated at the lower end and guarded with a fine gauze screen, and connected to a horizontal suction pipe which was attached to a pump on the ground surface. By this means it was possible to reduce the water down to a workable level of some 16ft. If the depth of excavation required three sets of suctions, giving a depth of, say, 48ft., the first set of pipes were placed about 60ft. back from the edge of the excavation. When the excavation of the first 16ft. was removed on a 45 deg. slope, a further series of vertical pipes were sunk at the foot of the slope about 18ft. nearer the pocket to be excavated, and the ground was left with a 45 deg. slope backwards to the upper row of vertical pipes. The second tier of pipes was connected as before to a horizontal suction pipe coupled to a second pump on the first stage level. The excavation was then taken down a further 18ft. At the foot of the new slope a third series of vertical pipes were sunk and coupled to a third horizontal suction pipe and pump on the second stage level. By this method it was possible to take out the excavation to the natural slope of the ground and thoroughly drain the water. Figs. 1 and 2 show the step-wise system as applied to the foundations of a museum in Berlin. The inconvenience of this system, however, arises from the necessity to take the work out in steps, which required sufficient room for a safe slope, or a very much wider trench with benchings for each series of suction pipes.

The new system, which has been introduced to this country by Messrs. Siemens BauUnion, and is now being handled through their agency along with Edmund Nuttall, Sons and Co. and John Mowlem and Co. (Joint), Ltd., consists of sinking pipe wells to the full depth required from the ground surface, in which centrifugal pumps are suspended to discharge the water. A pipe of sufficiently large diameter to provide for the pump and filter, say, 20in., is sunk for the full depth, and if the depth is too great

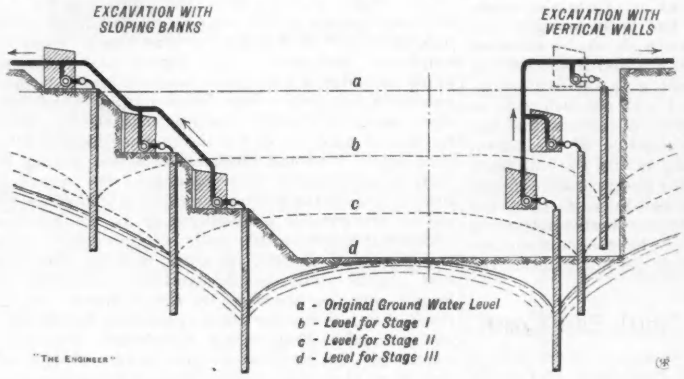

EXCAVATION WITH SLOPING BANKS
EXCAVATION WITH VERTICAL WALLS
a
b
c
d
a - Original Ground Water Level
b - Level for Stage I
c - Level for Stage II
d - Level for Stage III
"The Engineer"

Fig. 1—Stepwise Sinking

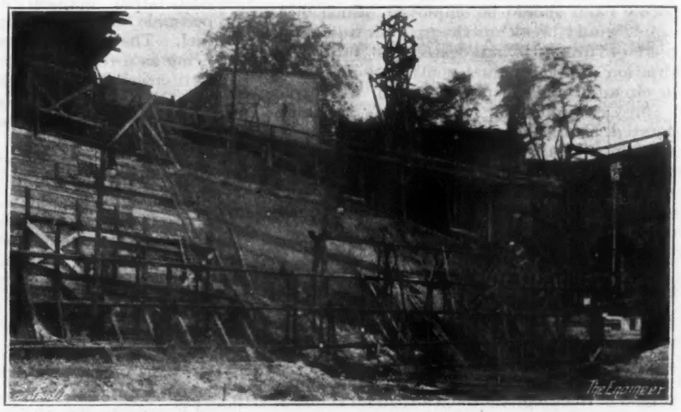


Fig. 2—Five-Stage Ground Water Lowering for the Berlin Museum

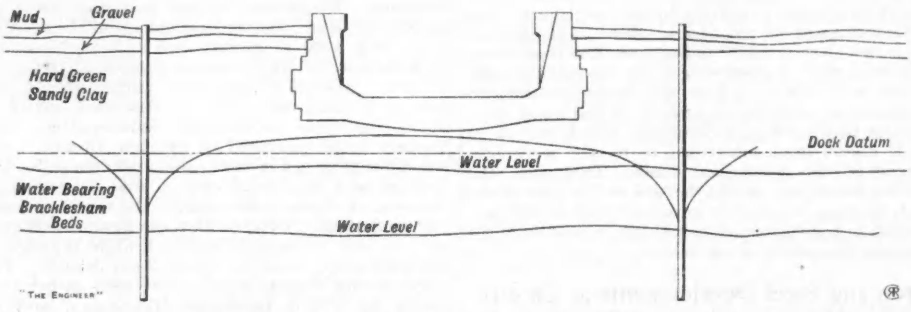


Fig. 3—Cross-Section of Southampton Dry Dock showing Wells and Water Pressure Curve

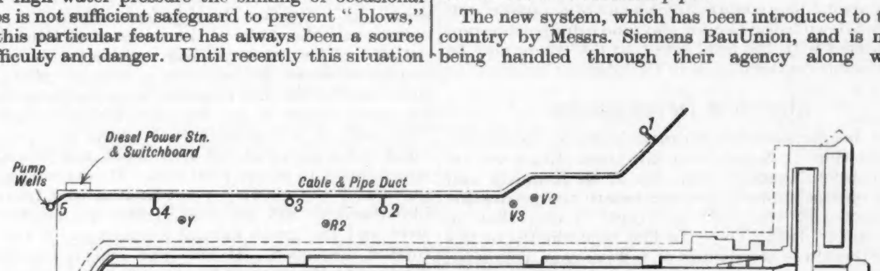


Fig. 4—Plan of Southampton Dry Dock, showing Position of Wells and Observation Pipes

to be taken with one length of 20in. pipe, then the first sinking is done in a 24in. pipe or larger, as required. Finally, however, a 20in. pipe reaches the bottom of the well to give room for the necessary filter and pump. In this well is lowered a 14in. pipe, the bottom length of which is perforated with fine herring-bone saw-cuts around which is wrapped extremely fine wire mesh. Around this length of sieve are placed graduated pebbles between the 14in. and the 20in. pipes to build up an efficient filter. Well-worked puddle is then dropped between the two pipes on top of the pebble filter, and the entire space between the pipes is filled with puddle during the process of extracting the 20in. pipe, the clay being well rammed to fill the annular space as the pipe is removed.

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* Read before the British Section, Société des Ingenieurs Civils de France on Tuesday, 24th October, 1933.

Should it be necessary to drain more than one layer of water-bearing sand, a second section of perforated pipe is inserted at the proper level in the 14in. line, with a filter of stones around it as before, resting on the puddle bed between the two filters.

A vertical centrifugal pump is then lowered into the 14in. well until it is suspended within the filter. When the pump is put into operation it withdraws clear water without the inflow of sand, and consequently forms an inverted cone in the reservoir of water which has to be drained.

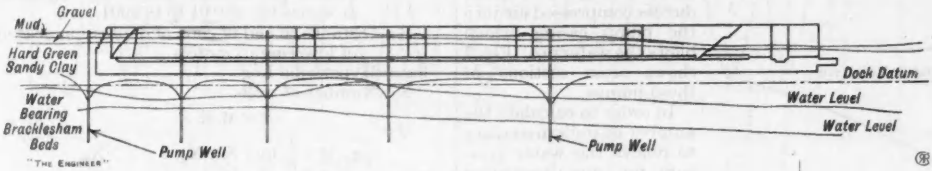


FIG. 5—LONGITUDINAL SECTION OF SOUTHAMPTON DRY DOCK WITH WELLS AND WATER PRESSURE CURVE

Additional wells are sunk at the necessary distances apart, so that the work to be done is surrounded with wells, and as each pump comes into operation there is formed an inverted parabolic cone of depression in the water reservoir at every well. The distance apart of the wells is calculated so that the intersection of the cones of depression never comes above the bottom of the finished excavation.

The first application of this system in this country was for the excavation of the dry dock being constructed at Southampton for the Southern Railway Company, under the direction of their docks engineer, Mr. F. E. Wentworth-Sheilds, M. Inst. C.E., by Edmund Nuttall, Sons and Co. and John Mowlem and Co. (Joint), Ltd., the contractors.

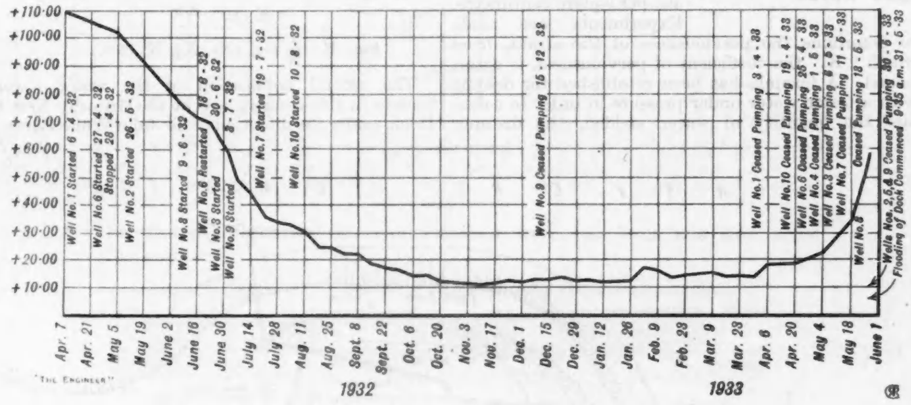


FIG. 6—EFFECT OF PUMPING AT SOUTHAMPTON DRY DOCK

In Fig. 3 is shown a cross section of this dock, with the relative positions of the wells on each side of the dock and the approximate curve of water pressure. Fig. 4 shows the plan of the dock and the positions of the bore-holes. Fig. 5 shows the longitudinal section with the wells and pressure curve of the artesian water.

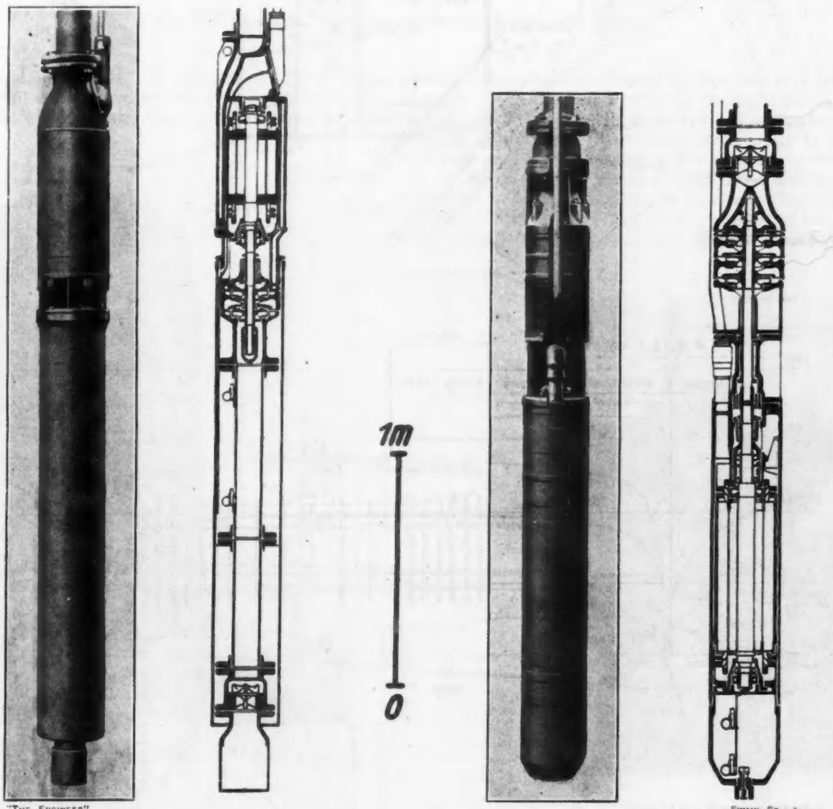


FIG. 7—CROSS-SECTION OF SUBMERSIBLE WELL PUMP, TYPES T-O AND T-U

The strata through which the excavation had to be taken varied, but generally consisted first of a bed of river mud of about 5ft., then a bed of ballast about 10ft. 6in., followed by a bed of hard green sandy clay varying from 70ft. to 100ft. thick, beneath which was a layer of sand and pebbles, commonly known as the "Bracklesham" Beds, containing artesian water, which rose to a height of 10ft. above the coping of the new dock. This represented a head of water of 94ft. at the underside of the invert of the dock, and 87ft. at the bottom of the dock wall.

Taking dock datum at zero, the coping was 100·00, the underside of the walls plus 23·00, and the underside of the invert in the centre plus 16·00. The artesian water rose to a height of 10ft. above the coping, or plus 110·00, and at the weakest point the underside of the bed of hard green sandy clay rose to plus 5·00, bringing the pressure of the artesian water within 18ft. of the bottom of the trench (as shown on the longitudinal section, Fig. 5), and within 11ft. of the bottom of the invert. This would have resulted, after excavation without lowering the artesian water, in an upward pressure on the underside of the trench of 1·95 tons per square foot, and on the underside of the invert a maximum of 2·36 tons per square foot, this being based on taking the water conservatively as dense as sea water at 64 lb. per cubic foot, and the hard green sandy clay at 130 lb. per cubic foot, which was determined by actual experiment.

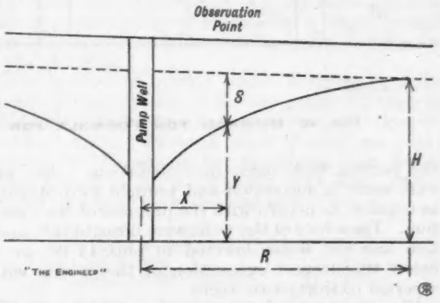


FIG. 8—DIAGRAM FOR FORMULA FOR GROUND WATER

In the trench 33ft. 3in. wide at the bottom, the layer of green sandy clay considered in the form of a concealed arch, would have been under a compressive force of 3·32 tons per square foot on the clay. If it is considered as a plug being forced upwards, there would have been a shear of 1·80 tons per square foot on both sides of the trench.

It is possible if the ground had remained dry that the trench might have withstood the upward pressure. In the case of the invert, however, much greater loads would have been experienced. As a concealed arch the compression on the clay under the invert would have amounted to 63·72 tons per square foot, and taken as a plug the shear on each side would have been 8·37 tons per square foot. Obviously, this would have given way under the pressure, and the walls being already built before the removal of the dumpling excavation, would have undoubtedly slid inwards. In fact, had it not been for the water lowering process, probably the dock, for a considerable length, would have had to be constructed, both as to walls and invert, by the monolith system at a greatly enhanced expenditure. Mr. Wentworth-Sheilds, consequently, determined that in order to carry out the work safely, the water-lowering system should be adopted.

FIG. 9—WELL SINKING AT SOUTHAMPTON DRY DOCK

Ten 20in. wells were sunk around the landward end of the dock as shown on Fig. 4, along with ten observation borings, 8in. diameter, for observing the water levels. Sounding pipes 2in. diameter, perforated at the bottom length and surrounded with a fine gauze screen, were placed inside the 8in. pipes, and a filter of graduated pebbles was made between the two pipes. After filling the annular space above the filter between the two pipes with clay, the 8in. pipes were withdrawn. An electric sounding apparatus was lowered down the 2in. pipes to obtain the water levels. The effect of pumping in the different wells is shown on Fig. 6, where the average head of the water is given week by week, with the dates on which the various wells came into operation. The wells were sunk in succession and brought into operation as required to accord with the progress of the excavation. The whole of the wells were brought into operation and the water lowered to plus 14·00, or 2ft. below the deepest excavation of the invert, within a period of thirty-two weeks.

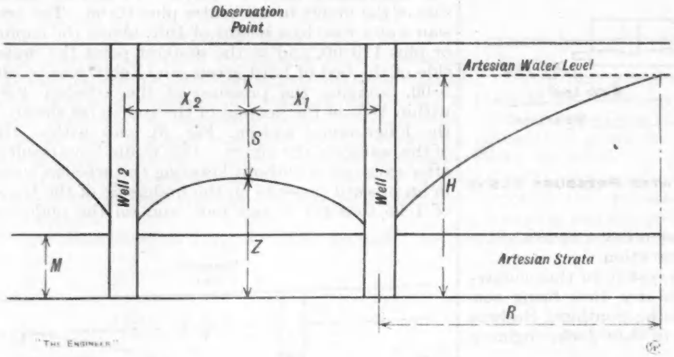

Observation Point
Artesian Water Level
X_2
X_1
S
Well 2
Well 1
H
M
Z
Artesian Strata
R
"The Engineer"

Fig. 10—Diagram for Formula for Artesian Water

The water was lowered without drawing in any sand from the "Bracklesham" Beds, discharging from the wells in a clear stream suitable for drinking, tasting like chalybeate spring water. The maximum amount of water pumped to effect the lowering of the artesian water referred to was only 60 gallons per pump per minute, or 600 gallons in all.

The wells were coupled on each side of the dock to a discharge main, which carried the water over the dam into the river. In order to guard against any undue uplifting pressure on the completed dock when it is empty, Mr. Wentworth-Sheilds arranged for the wells to be cut off at plus 60·00, so that when the pumps are removed the artesian water will be relieved at this level through horizontal pipes with flap valves passing through the dock walls.

There are two types of vertical centrifugal pumps used for this work, viz., the T–O type with the motor above the pump, and the T–U type with the pump above the motor.

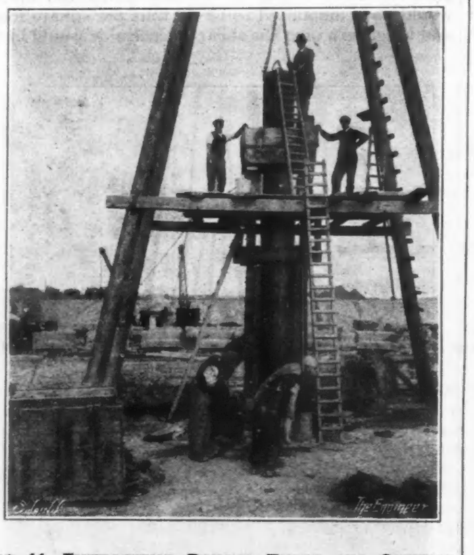


Fig. 11—Extracting Boring Tubes and Setting Filters at Southampton Dry Dock

The T–O form of pump was the first to be developed, and can be fitted with a lengthened suction pipe if necessary. The discharge water passes around the motor in a jacket cast outside the motor casing. One benefit of this pump is that it can be lowered to the very bottom of the bore-hole if required. The disadvantage of this T–O type of pump is that it has not been possible to make a T–O pump of this design that will work satisfactorily against a head of water greater than 98ft. It is also an exceedingly difficult pump to manufacture, and the motor is very inaccessible. The weight of the armature and the impeller have to be supported on a foot-step bearing, which adds to the difficulties.

The later type of pump, which is called the T–U pump, has the pump above the motor, and is of a smaller diameter than the T–O type. It deals with a much greater depth of water than the T–O pump, as it operates satisfactorily while discharging against a head of 328ft., and is, consequently, suitable for deep mining shafts and oil wells. The reaction of the pump impeller helps to carry the weight of the spindle and armature. As there is always a slight leakage of water into the motor casing from the gland, the casing is kept charged with compressed air. Should the water rise above a predetermined point in the casing, electric contact is made and a bell rings in the engine-room, indicating that that particular pump requires attention. The attendant, by touching a button, directs compressed air into the pump casing, which blows the water out. Fig. 7 shows cross sections of these pumps.

In order to calculate the number of wells necessary to relieve the water pressure for any particular job, certain particulars are required as to the density and size of the grains of the sand which is charged with water. Samples of the sand are obtained from a trial boring, and the grains are examined under a microscope to determine how many grains there are per square centimetre. Experiments are made to determine the perviousness of the strata, from which "K," the coefficient of perviousness, is determined. A formula has been established for dealing with artesian water under pressure in order to calculate the quantity of water yielded, the distance between the wells, and the amount the water pressure will be lowered.

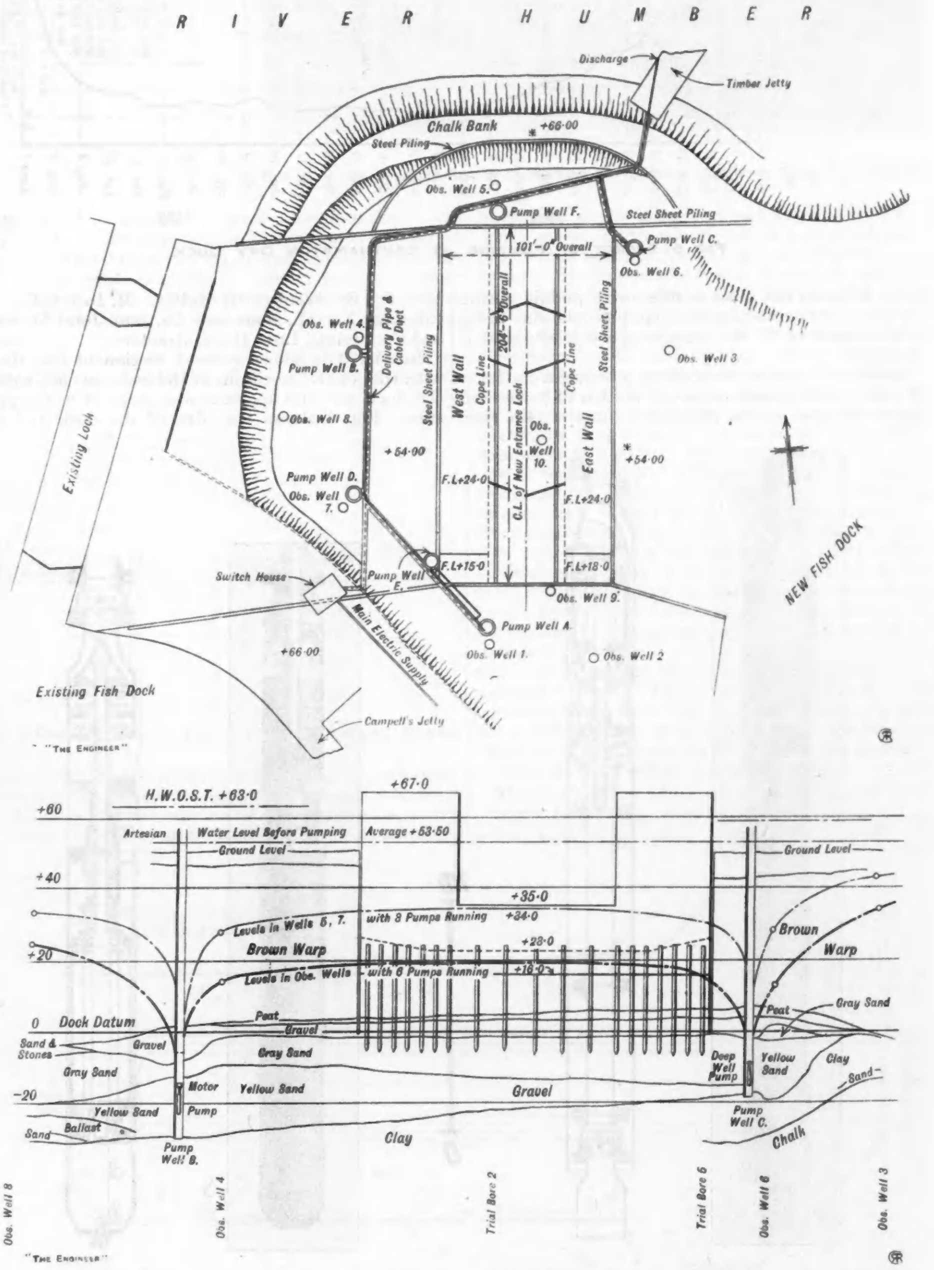

RIVER HUMBER
Discharge
Timber Jetty
Chalk Bank
+66·00
Steel Piling
Obs. Well 5.
Pump Well F.
Steel Sheet Piling
101′-0″ Overall
Pump Well C.
Obs. Well 6.
Obs. Well 4.
Pump Well B.
Delivery Pipe & Cable Duct
Steel Sheet Piling
West Wall
Cope Line
204′-6″ Overall
C.L. of New Entrance Lock
Cope Line
Steel Sheet Piling
Obs. Well 3.
Obs. Well 8.
+54·00
Obs. Well 10.
East Wall
+54·00
Existing Lock
Pump Well D.
Obs. Well 7.
F.L+24·0
F.L+24·0
F.L+15·0
F.L+18·0
Switch House
Pump Well E.
Obs. Well 9.
Main Electric Supply
Pump Well A.
Obs. Well 1.
Obs. Well 2
+66·00
NEW FISH DOCK
Existing Fish Dock
Campell's Jetty
"The Engineer"
H.W.O.S.T. +63·0
+67·0
+60
Artesian
Water Level Before Pumping
Average +53·50
Ground Level
Ground Level
+40
+35·0
Levels in Wells 6, 7.
with 8 Pumps Running
+34·0
+28·0
Brown Warp
Brown
Warp
+20
Levels in Obs. Wells
with 6 Pumps Running
+16·0
Peat
Peat
Gray Sand
0
Dock Datum
Gravel
Sand & Stones
Gravel
Gray Sand
Gray Sand
Deep Well Pump
Yellow Sand
Clay
Motor
Yellow Sand
Gravel
Sand
-20
Yellow Sand
Pump
Pump Well C.
Ballast
Sand
Clay
Chalk
Pump Well B.
Obs. Well 8
Obs. Well 4
Trial Bore 2
Trial Bore 6
Obs. Well 6
Obs. Well 3
"The Engineer"

Fig. 12—Grimsby Dock Plan showing Wells and Observation Tubes with Cross-Section

Fig. 10 shows a typical cross section with the necessary symbols required in the formula, as outlined here :—

Q=Quantity of water pumped in cubic metres per second.

S=Depth that artesian water has to be lowered in metres.

X_1, X_2, &c., are horizontal distances of pump wells from observation points.

M=Thickness of water bearing (artesian) strata in metres.

K=Coefficient of perviousness of the strata in metres per second, based on experience. It varies from 0·01 to 0·0001.

R=Distance to end of cone of depression or range of lowering in metres.

$\log_e$=Hyperbolic Log.

N=Number of wells.

$$Q=\frac{2\pi MKS}{\log_e R-\frac{1}{N}\log_e X_1, X_2, \ldots X_n}$$

Where ordinary ground water has to be dealt with, the formula is slightly different. Fig. 8 gives a diagram showing the symbols in the formula, which are as follow :—

Q=Quantity of water pumped in cubic metres per second.

K=Coefficient of porosity of the strata.

H=Depth of water-bearing ground.

S=(H—Y) Lowering of water at observation point.

X=Distance from well to observation point.

$$Q=\frac{\pi K(H^2-Y^2)}{\log_e R-\frac{1}{N}\log_e (X_1, X_2, X_3, \&c.)}$$

The second application of the water lowering process in this country was at the Grimsby New Fish Dock, under the direction of Sir John Wolfe Barry and Partners, the water lowering being carried out for the contractors constructing the dock and lock—Sir Lindsay Parkinson and Co., Ltd.—by Edmund Nuttall, Sons and Co. and John Mowlem and Co. (Joint), Ltd.

On Fig. 12 is shown a plan of the entrance lock for the New Fish Dock, with the position of the wells and observation tubes, along with a cross section giving the curves of water pressure after the pumps were in operation. Six pump wells were sunk and ten observation wells. These observation wells were sunk first to determine the best location for the pump wells. The strata was proved in this way to vary considerably, and the wisdom of thus selecting the points for the pumping wells was justified, as it was found that towards the south-easterly part of the lock the impervious clay rose about 29ft., the water-bearing strata consequently sloped from a thickness of 30ft. on the west to only 3ft. thick on the east side. In this case, although the water was artesian, its pressure was directly affected by the rise and fall of the tide. Fig. 13 shows that the fluctuations in the various observation wells synchronised with the rise and fall of the tide. The observation wells 1, 2, 3, and 8 show much higher water levels than the others on account of the clay strata at that point holding up the water. Dock datum in this case was 67ft. below cope level, the greatest depth of excavation for the lock being plus 16·00, and the general foundation level being plus 24·50. Generally speaking, the water level was kept below plus 20·00. It is of interest to note on this typical weekly diagram that during all week-ends, in this case May 27th, 28th, and 29th, the water level rose about 3ft. and then fell on the 30th, resuming the old level. The reason for this was discovered to be due to the factory wells in the district, which draw their water from this artesian reservoir, shutting down their pumps over the week-end, thus allowing the water to accumulate. To maintain a lower level additional wells would have been necessary.

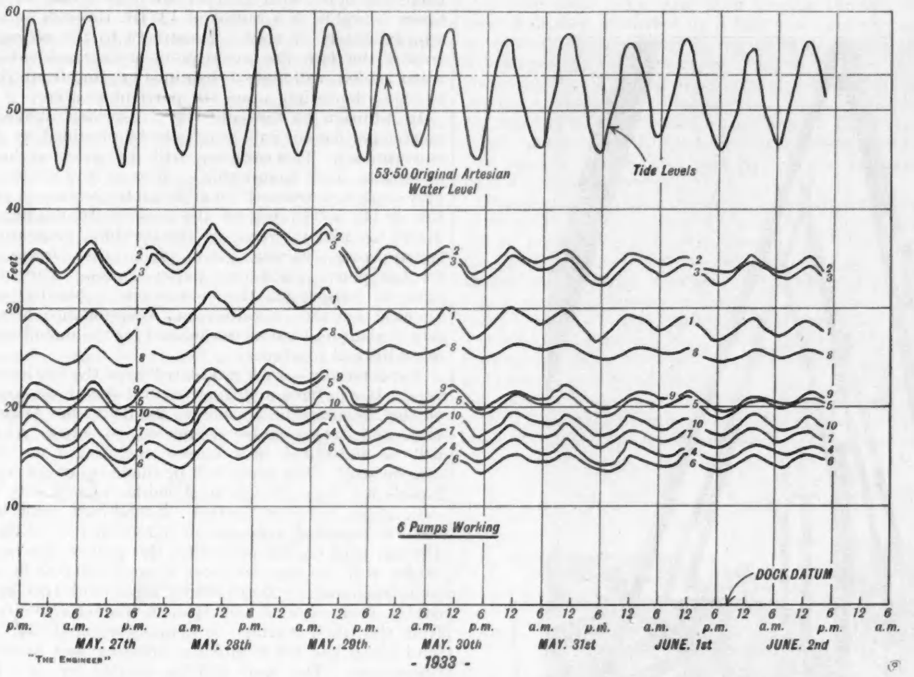


Fig. 13—Water Levels at Grimsby showing Rise and Fall for One Week

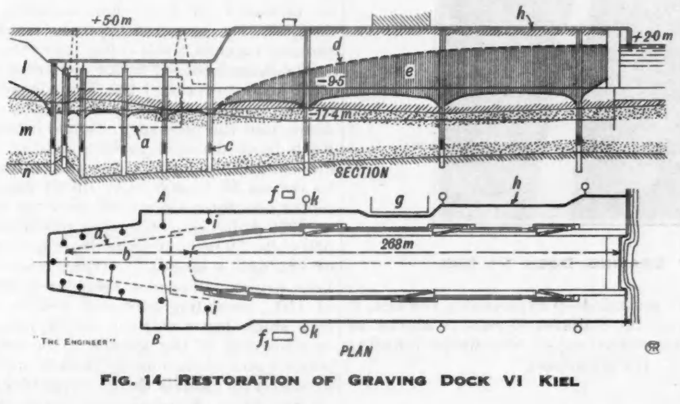


Fig. 14—Restoration of Graving Dock VI Kiel

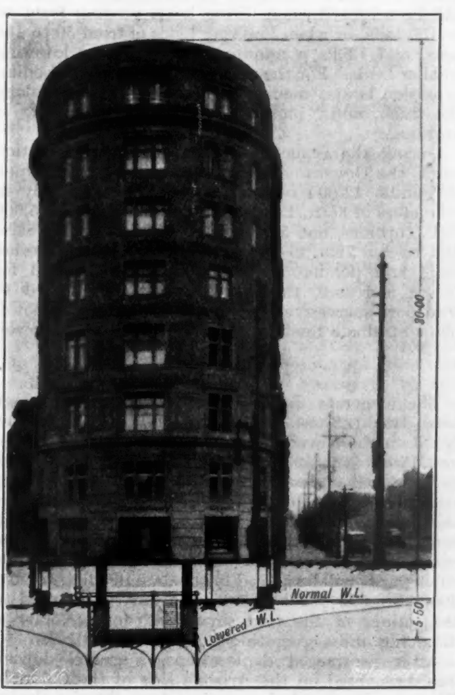


Fig. 15—B.U.R.—Construction of a Deep Basement under Existing Building

In constructing the work the engineers and contractors had not anticipated that there would be a sufficient upward water pressure in the sand and gravel to lift the intervening bed of brown warp, which is some 20ft. thick, to the underside of the lock. The trench for the west wall, enclosed in steel sheeting, had been excavated, and part of the concrete wall had been constructed supported on timber piles, when a "blow" occurred at the southern end. The "blow" resulted in a considerable inflow of sand, which caused a settlement of the concrete west wall already built and serious breaks in it, this in spite of the fact that the wall was carried on timber piles. Work was suspended until the water lowering pumps were in operation. When the part of the wall which had subsided had been removed it was found that the piles had lost their set, and it was necessary to re-drive them before replacing the wall. Since then both walls have been constructed and no further movement has been observed apart from a slight inward movement of the toe of the wall during the excavation for the dumpling.

This method of ground water lowering by submersible pumps in deep wells was originally tried in 1927 on the Continent with great success. The deepest lowering depths obtained were during the construction of the sluices for the North-East Canal (Kieler Kanal) in North Germany with 72ft. Other remarkable depths were obtained as follows :—

Southampton Dry Dock	96ft.
North Lock, Bremerhaven	66ft.
Sea Lock, Emden	63ft.
Sea Lock, Ymuiden (Holland)	66ft.

The construction of a tunnel under the Spree for the Underground Railway of Berlin was interesting, in that the tunnel was built in two sections, each section being shut off against the water of the river by double sheet pilings filled between with sand. After the completion of the enclosing dam for the left section out to the middle of the river deep wells were installed inside the cofferdam, and the ground water under the bottom of the river bed was so effectively lowered that the excavations could be proceeded with in completely dry ground as if there had never been any ground water pressure. The second half of the tunnel was dealt with in the same way as well as the approaches. The effect of the water lowering was that the time required was considerably shortened. Here the lowering depth was 40ft. below the bottom of the river bed.

Since 1927 the extension of the Berlin Underground Railway has been carried out by means of the ground water lowering system, more especially in the centre of the town, where the tunnels had to be built under blocks of houses—see Fig. 15.

The ground water lowering method was also successfully applied where damaged buildings have to be restored, and the deep well lowering showed its many advantages. The restoration work at No. VI. Dock in Kiel—see Figs. 14, 16, and 17—which showed fissures in the side walls and the bottom, the side walls having sunk considerably, was carried out under the protection of the ground water lowering process. This restoration scheme provided for the interior of the dock being lined with reinforced concrete, which was fixed to the walls by means of iron braces. As several springs carrying sand rose from the dock bottom during ordinary pumping operations, the ground water lowering plant was installed and completely removed this danger.

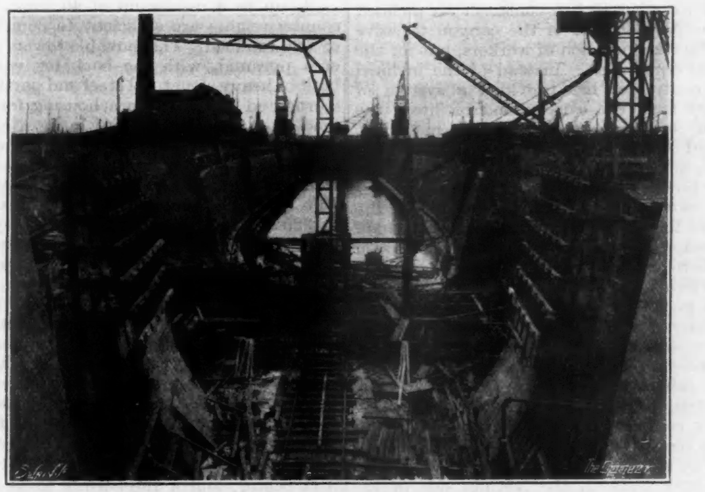


Fig. 16—Restoration of Graving Dock VI Kiel

In Bremerhaven the construction of the North Lock and the extension of the Kaiser Dock II. were carried out with the water lowering process. Here an impervious layer of clay reaches to a depth of 60ft., and below the clay there is a layer of sand of varying thickness from 1ft. to 20ft. under artesian water pressure. The foundation of the lock heads and the dock extension rested on this layer of sand. Sufficient reduction of the artesian pressure was achieved so that the whole of the work could be executed without difficulties arising from the water pressure.

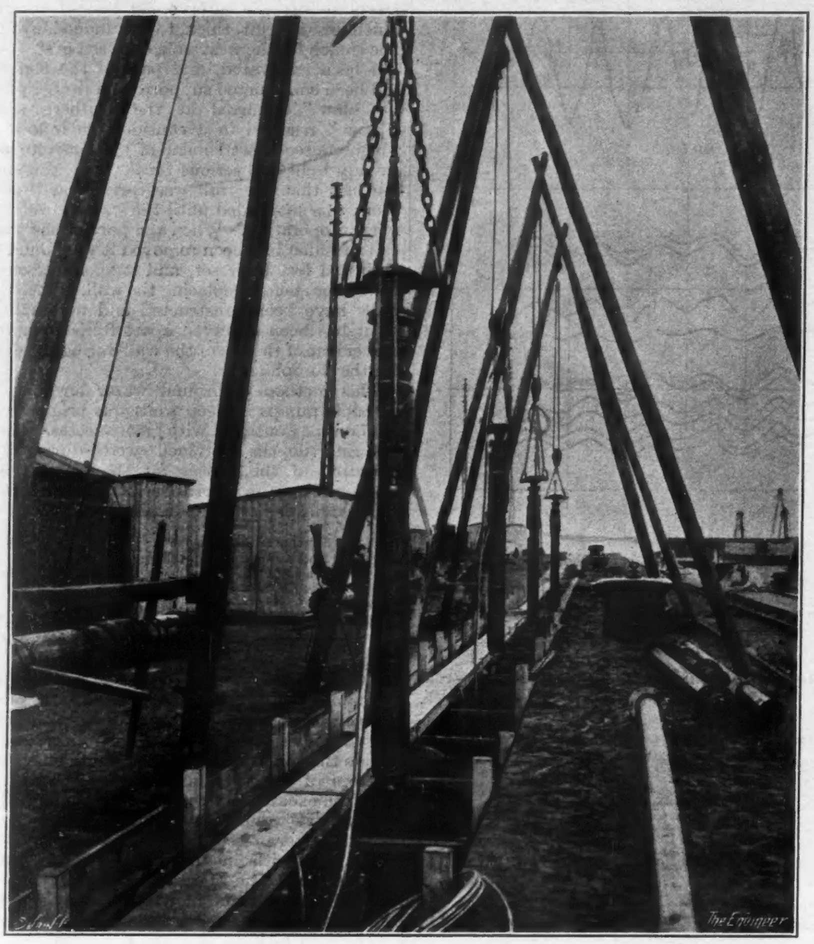


FIG. 17—WATER LOWERING PUMPS FOR RESTORATION OF GRAVING DOCK VI KIEL

There are other examples which might be mentioned, but sufficient have been described to show that the water lowering process by deep well pumps in one stage is a successful means of overcoming what formerly constituted a serious difficulty in constructing heavy civil engineering works.

In future, by a careful study of the geological strata supplemented by several deep exploratory borings, it will be possible for the engineer to remove all risk of "blows" by the utilisation of this water lowering process.

(To be continued.

The Hoover Dam on the Colorado River.

No. II.

(Continued from page 376, October 20th.)

CABLEWAYS.

BEFORE Six Companies, Incorporated, started operations the plan was to construct an inclined railway on the Nevada side of the canyon to serve not only for the transporation of workers, but for the handling of all equipment. Instead of the inclined railway, the contractor has provided a system of cableways that span the canyon and facilitate the transportation of workers, structural materials, machinery, and equipment of various kinds. Caterpillar tractors, heavy motor trucks, and considerable parts of large power shovels have thus been lifted or lowered and moved from point to point. In the earlier stages of the operations in Black Canyon small service cableways were erected near the diversion tunnel portals to move heavy equipment across the river, to build temporary steel suspension bridges, and to carry men to points where they could do scaling work on the canyon walls. Later on, these cableways were utilised in erecting Stoney gates, steel bulkhead gates, and the foundations for trash racks. Still another small cableway was thrown across above the valve house sites, and has served to transfer men and materials from rim to rim of the canyon and also to carry them to the valve house sites. All these cableways are of the stationary tower type, having their hoists and power units on the Nevada side of the canyon. To cover the sites of the spillways intake, towers, and dam, Six Companies, Incorporated, has installed five 20-ton cableways. These cableways have self-supporting movable towers at the head ends of four of the units and at the tail ends of all five. They are situated at strategic positions and make all parts of the working area accessible.

The track cable for each installation is of the lock-coil type, 3in. in diameter, and capable of carrying 450 tons. The endless rope is a steel cable 1in. in diameter and the hoist and dump ropes are ⅞in. in diameter. The cableways have been designed for normal operations not requiring loads of more than 20 tons, but they are capable of handling infrequently loads up to a maximum of 40 tons. The concrete counterweights are sufficient to counteract the pull of a 60-ton load. The movable towers are in the form of a pyramid, with the back leg vertical, and are built of heavy structural steel and partly covered with corrugated iron to form a housing for the operating machinery. The floors are built of chequered steel plate. In order to eliminate the risk of fire no wood is used in the structures. The towers vary in height from 17ft. to 90ft., their widths range from 20ft. to 46ft., and their lengths along the track are from 20ft. to 32ft. The towers are supported by from four to eight trucks, and each truck runs on two pairs of wheels, 33in. in diameter, travelling upon two parallel standard-gauge tracks placed between 19ft. and 45ft. apart. The vertical component of the pull of the cable on each tower is resisted by a massive block of concrete weighing from 400,000 lb. to 1,052,000 lb., placed above the rear trucks. The horizontal component of the cable pull is counteracted by trucks on the tower bearing against a centre rail placed with its web horizontal or by elevating the front rail of the front track.

Each cable is operated by a 500 H.P., 2200-volt A.C. motor, and a three-drum hoist equipped with band brakes and V-type wood-block clutches. The brakes are actuated by compressed air. Safety features are provided whereby the brakes are applied automatically in case of power failure, overloading, overspeeding, or by reason of the incapacity of the operator. The load can be conveyed on the track cable at a rate of 1200ft. per minute, and lowered or hoisted at a speed of 300ft. per minute. A tower is moved on its tracks by a motor and hoist in the structure—the hoist being attached by a single cable and through sheaves to an anchorage at each end of the track runway. A single electrical circuit, operated from the head tower, synchronises the movement of the head and the tail towers. Two of the cableways have a span of 1405ft.; two others have a span of 2575ft. The fifth cableway is of the radial-travelling type, with its head tower fixed and its tail tower movable at a radius of 1374ft. through an arc approximately of 600ft. Relatively to the ultimate crest of the dam, the lowest point of the track cables, when loaded, will have a clearance varying from 57ft. to 88ft., depending upon the particular cable.

In addition to the cableways described above, a master permanent cableway is to be provided by the Government. This cableway will, it is asserted, have a capacity more than twice as large as any cableway previously constructed. In addition to the transportation of the steel pipes for the pressure tunnel lining, it will be used to transport the turbines, generators, transformers, valves, gates, and other materials for the power plant and outlet works. After the dam is completed, the permanent cableway will be used for the operation and maintenance of the power plant and outlet works, and for the installation of additional machinery.

The cableway—see Fig. 11—will be of the stationary type. It will have a 90ft. structural steel head tower on the Nevada side, a concrete saddle on the Arizona side, and track cables connected to I-bars which will be imbedded in concrete anchorages in each canyon wall. The track will be made up of six 3½in. Lang's lay superplough steel cables placed side by side, 18½in. between centres. Each track cable will have a breaking strength of 1,700,000 lb. With a 150-ton load on the cableway, the pull of the track cables will amount to more than 2,000,000 lb. on each anchorage. Two endless ropes and two hoist cables, each of steel and 1⅛in. in diameter, will run from the track carriage to drums for conveying the load along the track and for lowering and hoisting operations. The load will be carried by two fall blocks which will be suspended from the track carriage by a reeving of hoist ropes. The track carriage will be mounted on forty-eight sheaves, each 24in. in diameter, for travelling upon the track, eight sheaves running on each track cable.

The hoist house is under construction between the steel head tower and the Nevada anchorage. It is to accommodate two hoist drums, one conveying drum, and the necessary electric power control units. Each hoist drum is to be operated by a 125 H.P. direct current motor, while the conveying drum will be driven by a 400 H.P. direct current motor. A motor generator set will convert the received current at 2300 volts and 60 cycles into working current at 550 volts. The conveying drum is to have a diameter of 8ft. and a length of 10½ft., and each of the two hoist drums will have a diameter of 13ft. and a length of 17ft., providing sufficient area to wind the ropes in a single layer without overlapping. Deceleration and braking of the load is to be secured by motor control and operation, by brakes on the hoist drums actuated by electric thrustors and by solenoid brakes on the axles of the driving motors. Equipment is to be provided whereby the load will be automatically decelerated and brakes applied in the event of overloading, overspeeding, or power failure. It will be possible to operate the track carriage at a speed of 240ft. a minute. A speed of about 30ft. a minute will be achieved when lifting loads ranging from 40 to 150 tons, or when lowering loads of from 50 to 150 tons, and 120ft. a minute when lifting or lowering smaller loads. For the nice handling of heavy bodies, provision is also made for "creeping" speeds along the track, and "inching" speeds when hoisting or lowering.

During the remaining years of the construction work, the Government cableway will be called upon to handle 42,000 tons of steel pipe, principally in diameters of 8½ft., 13ft., 25ft., and 30ft., four 115,000 H.P. turbines, one 55,000 H.P. turbine, twelve 84in. and twelve 72in. needle valves, and numerous other large and ponderous details. As the demand for power increases, the cableway will be utilised to transport successive generator units until the power plant attains a final rating of 1,835,000 horse-power.

TRASH TANKS.

The concrete foundation for the 100ft. high trash track at the inlet portal of Diversion Tunnel No. 2 on the Nevada side of the canyon was poured on March 5th, 1932. This concrete was the first to be placed under the general contract for the construction of the Hoover Dam, the power plant, and the appurtenant works. Before the undertaking is completed, approximately 4,400,000 cubic yards of concrete will be poured. Of this volume, 3,400,000 cubic yards will be placed in the dam itself. Already, 300,000 cubic yards of concrete have been used in the linings of the four diversion tunnels, 50ft. in diameter, and aggregating 15,934ft. in length.

After protracted explorations, a gravel deposit was discovered on the Arizona side of the Colorado River 6 miles north, by air line, from the site chosen for the dam. The deposit lies along the river, covers an expanse of more than 100 acres, and has an average depth in excess of 30ft. The choice was made after testing gravel from more than a score of deposits lying within a radius of 50 miles from the dam site. Care in the matter was essential because the specifications prescribed that mass concrete should have a compressive strength of 2500 lb. per square inch, and that thin concrete sections should have a compressive strength of 3500 lb. per square inch. The aggregates, composed of sand and gravel, are excavated from the Arizona deposit by a 5 cubic yard electric drag-line, dumped into 50-ton side-dump cars, hauled across the Colorado River on an 850ft. pile-trestle bridge, and carried thence by railway to the screening plant 6 miles distant. At that point the material is dumped into bunkers from which it is transported by belt conveyors to rotary and vibrating screens that separate the pit material into sand and into four sizes of gravel. Thereafter, another series of conveyors deposits the different products into so many stock piles. The sand and each size of gravel are loaded by belt conveyors into separate railway cars and hauled 4·7 miles to the concrete mixing plant, known as Lo-Mix Plant, situated in Black Canyon about a mile upstream from the dam site. The Arizona gravel deposit is worked continuously in three shifts daily, and the average output per day varies between one hundred and fifty and two hundred 50-ton carloads. The screening plant is situated in a flat area 2 miles west of the river in Hemenway Wash, and is at what is known as Three-Way Junction, on the contractor's railway, where a branch connects with the United States construction railway that runs to Boulder City—see map, Fig. 2, in our issue of December 9th, 1932.

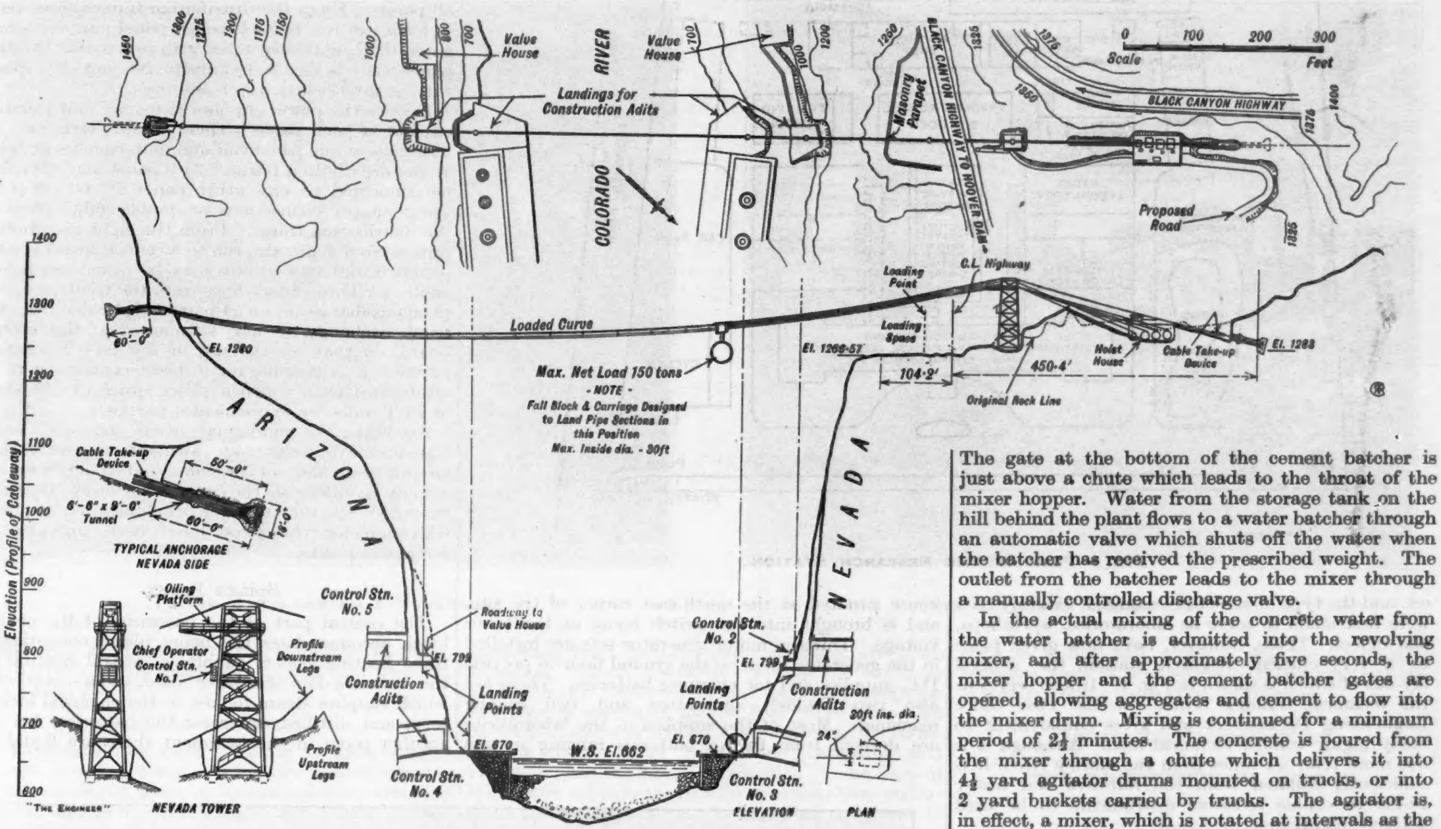


Fig. 11—The Permanent Cable Way

Screening and Washing Plant.

The screening plant consists principally of a crusher, four classification towers, a sand washer, a sand shuttle conveyor, four storage piles, and sand storage piles. A 42in. belt conveyor, running beneath the raw storage bunkers, moves the material and dumps it into a 20ft. cylindrical revolving screen. This screen permits all material of less than 9in. in maximum dimensions to pass through it, and dumps cobbles above this size on to a transverse conveyor that feeds a gyratory crusher. The output from this crusher is returned by suitable conveyors to the screen. Material of less than 9in. size is fed to a 36in. belt conveyor, which delivers it to the first classification tower in which there are two vibrating screens. The first screen allows aggregates of less than 3in. in size to pass and dumps material ranging from 3in. to 9in. on to a transverse conveyor which moves the stuff to a stock pile. The second screen passes sand and material of less than ¼in. in size through its perforations, and dumps all gravel on to a lateral conveyor that runs to the second classification tower. In a similar manner the vibrating screens and transverse conveyor at this second station remove the 1½in. to 3in. gravel to a stock pile, and the lateral conveyor transports material of less than 1½in. in size to the third tower. Here, gravel of ¾in. to 1½in. size is removed to a stock pile, and all materials that pass through the screen are conveyed laterally to the fourth tower, where a transverse conveyor carries the gravel of ¼in. to ¾in. size to its stock pile.

The sand removed by the vibrating screens in the first classification tower is delivered by chute to a series of mechanical sand washers or classifiers. The water and silt separated from the sand overflows through a flume to a sedimentation tank equipped with a classifier and sludge pump. The water from this classifier is delivered to a sump tank and then pumped to a sedimentation tank on an adjacent hill and is re-used. The sand after passing through the second washer is carried by a belt conveyor through a concrete tunnel beneath the railway tracks and discharged on to a conveyor running parallel with those tracks. This conveyor connects with a tripper serving two transverse conveyors. By these means the sand may be piled on either side of the lateral supply conveyor and parallel with the railway tracks. The sand is loaded into cars by a crane equipped with a clam-shell bucket.

The screening plant has a capacity of something more than 500 tons an hour, and four 50-ton cars can be loaded every sixteen minutes. By increasing the speed of the conveyor belts and making slight alterations in other directions, the capacity of the plant can be increased to 1000 tons an hour. The plant is run by electric power, and is controlled from a central switching station. Thirty-four sets of push-button switches control all the units of the plant, and one switch can stop all operations. Water for washing purposes is pumped from the Colorado River, by stages, through 2 miles of 12in. pipe, against a static head of 415ft., to a sedimentation tank on a hill south-east of the plant. The character of the silt in the river water is such that 98 per cent. of it can be removed by a detention period of three hours in the tank. Water from the river contains an average of 6000 parts per million of silt, and water, sent to the screening plant, must not have more than 500 parts per million. The pre-sedimentation tank, constructed of reinforced concrete, is 150ft. in diameter and 15ft. high. It has a capacity of 800,000 gallons, and is equipped with a clarifier. Sludge is removed by gravity. The screening plant represents an outlay of about 450,000 dollars.

Concrete Mixing.

The Lo-Mix plant occupies a natural shelf at the foot of the canyon wall, which was enlarged to provide accommodation for a structure 78ft. wide and 118ft. long in plan. The plant is 88ft. in height from the truck-loading platform to the top of the storage bins. The bins at the top of the plant are six in number—three for gravel, one for cobbles, one for sand, and one for cement. They are of steel-frame construction with laminated timber sides and partitions. The walls are of 3in. by 8in. to 3in. by 12in. planks, and the floor is of 3in. by 16in. planks. The cement bin is covered and is waterproofed on the inside with tar and felt. Cement is delivered in bulk and transferred from the cars to the bin through a 6in. steel pipe pneumatically by two 40 H.P. Fuller-Kinyon pumps. The water used at the mixing plant is pumped from the river to a clarifier 50ft. in diameter, situated on the canyon wall a quarter of a mile farther upstream. All silt in excess of 500 parts per million is settled out in this tank, and the water flows thence by gravity to a 125,000-gallon storage tank set up in a side canyon above the mixing plant.

The mixing plant at present contains four 4 cubic yard tilting mixers, but at peak production it will probably have in service four more mixers of the same capacity. In addition, there are two batchers for each mixer for water, cobbles, sand, and gravel, and four batchers for cement. Each batcher alternates in serving two mixers, and is provided with a weighing, cut-off, and recorder beam, and a full-capacity dial above the beam box. The plant contains two supply conveyors capable of moving 1500 tons of aggregates an hour. The storage bins have a total capacity of 5400 cubic yards of aggregate and the equivalent of 14,800 barrels of cement. The principal power equipment consists of 75 H.P. motors for each mixer, and 200 H.P. motors for each of the supply conveyors. When in operation, sand and gravel of the prescribed sizes are dropped through an automatically controlled gate and discharged into a batcher placed below each bin. Doors in the bottom of the batchers are opened in rotation by air-controlled, electrically operated apparatus, and the aggregates are spread in thin layers on a 48in. belt conveyor that leads to a mixing hopper above and behind a mixer. When the 3in. to 9in. cobbles are used, they are released through a door in the bottom of the cobble bin and drop on to an automatically controlled steel belt conveyor and go to the cobble batcher. For each mixer, cement runs from the cement bin through four chutes to an automatically controlled, double-screw-conveyor cement feeder, placed at the top of the cement batcher.

The gate at the bottom of the cement batcher is just above a chute which leads to the throat of the mixer hopper. Water from the storage tank on the hill behind the plant flows to a water batcher through an automatic valve which shuts off the water when the batcher has received the prescribed weight. The outlet from the batcher leads to the mixer through a manually controlled discharge valve.

In the actual mixing of the concrete water from the water batcher is admitted into the revolving mixer, and after approximately five seconds, the mixer hopper and the cement batcher gates are opened, allowing aggregates and cement to flow into the mixer drum. Mixing is continued for a minimum period of 2½ minutes. The concrete is poured from the mixer through a chute which delivers it into 4½ yard agitator drums mounted on trucks, or into 2 yard buckets carried by trucks. The agitator is, in effect, a mixer, which is rotated at intervals as the concrete is being transported, thereby ensuring uniformity of consistency and density. The buckets, two of which are transported on each truck, are of the bottom-dump type. While one batch of concrete is being mixed, another is discharged into the mixer hopper and the cement and water batchers are re-loaded. At full capacity, with all four mixers in action, 16 cubic yards of concrete can be produced by the plant in 3½ minutes.

The Lo-Mix plant will be dismantled and its equipment removed to amplify the high level, or Hi-Mix plant when the dam, with the water impounded by it, reaches a certain height. The Hi-Mix plant, on the Nevada side of the canyon, is already under construction, and after the dam has reached an elevation of 395ft. above the bed of the river, this plant will provide all the concrete for the completion of the structure. To begin with, this high-level plant is being equipped with two 4 cubic yard mixers.

(To be continued.)

INSTITUTION OF NAVAL ARCHITECTS.

The Council of the Institution of Naval Architects has made the following awards:—

Institution of Naval Architects Scholarship (1933), £130 per annum for three years at the Royal Naval College, Greenwich, to Mr. R. E. Tozer, of Devonport Dockyard.

Earl of Durham Prize to Mr. H. W. J. Chislett, of Devonport Dockyard.

Duke of Northumberland Prize (in connection with the 1933 examinations for National (Higher) Certificates in Naval Architecture) to Mr. Alexander Stewart, of the Technical College, Sunderland.

1851 Exhibition Commissioners Post Graduate Scholarship in Naval Architecture (1933), £250 per annum for two years, to Mr. H. J. Tabb, of the Royal Naval College, Greenwich.

Sir William White Post Graduate Scholarship in Naval Architecture (1933), £150 per annum for two years, to Mr. Will Pratt, B.Sc., of Durham University (Armstrong College, Newcastle-on-Tyne).

The Post Office Research Station.

ALTHOUGH the assertion that Great Britain lags behind others in the field of research may have been true a few years back, in some directions, at any rate, she now easily holds her own. It is doubtful, for instance, if a more elaborate or better equipped establishment devoted to electrical communication investigations can be found than the British Post Office Research Station at Dollis Hill, opened by the Prime Minister on Monday last. A site of 8 acres was purchased for the station in 1920, but as the cost of erecting buildings at that date would have been excessive, and as a certain amount of experience was desirable in order to be sure of the most suitable lay-out and the type of structure required, ex-army huts were first made to serve as laboratories, workshops, and offices. These, however, have now given place to a very efficient research station, the general lay-out of which is shown in Fig. 1. It also serves as the technical training centre for the Post Office Engineering Department and gives employment to many highly trained technical men. Although it is not more than six miles from the Marble Arch, it is sufficiently isolated from the railways and heavy traffic to enable sensitive instruments to be used without disturbance.

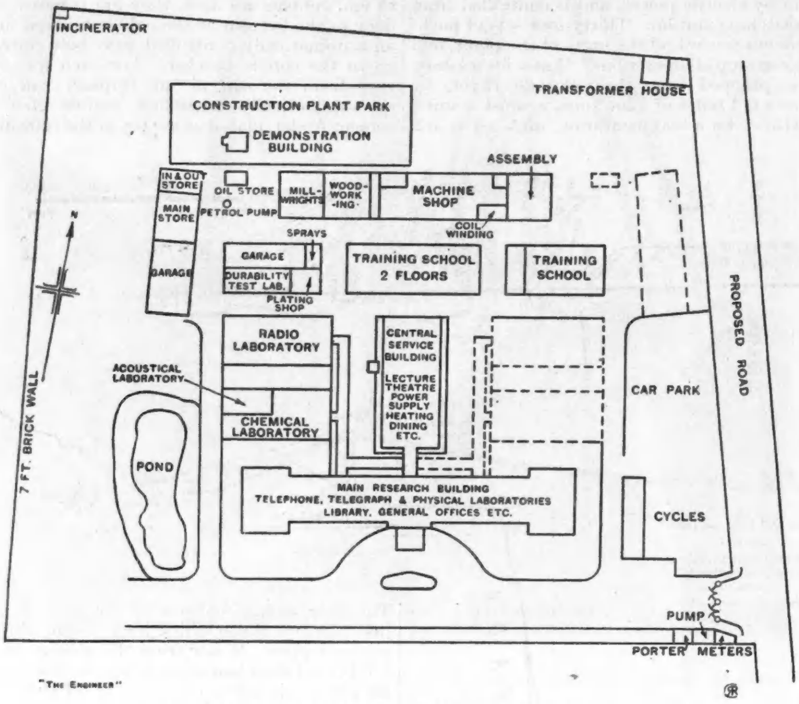


FIG. 1—PLAN OF THE RESEARCH STATION

BUILDINGS.

The main building with three floors contains offices and laboratories equipped with the most up-to-date apparatus, and in every way suitable for the work upon which the research staff is engaged. Situated on the ground floor, the offices serve for the administration and clerical staffs. At the western end of this floor there are laboratories for physical and special electrical tests, whilst the eastern end is devoted to work on exchange signalling methods and apparatus. At the western end of the first floor apparatus transmission measurements are made, and the specially silenced laboratories used for some of this work are ventilated by a system connected to the ventilating fleche on the roof. The laboratories at the eastern end at this level are used for research on line transmission problems, while telegraph laboratories occupy the western end of the second floor, which accommodates the library in the centre. At the eastern end there are laboratories for cable tests and records and for dealing with the development and construction of research apparatus. With the exception of two laboratories in the basement, three rooms of the second floor devoted to training, and the attic floor, the adjacent central block serves for the provision of services. The attic of this building, together with part of the attic floor of its research block, is occupied by photographic studios and dark rooms.

The main research block, consisting of a building some 286ft. long, with its three principal floors, stands on the crest of Dollis Hill, facing south. Attached to it on the northern side is the central block of similar height, and a number of independent single-storey laboratories east and west of the central block are connected with the latter and the main block by covered ways. Separated from the northern end of the central block by a roadway is the two-storey Automatic Training School building, and further to the north the workshops are accommodated in a building some 240ft. long and 40ft. wide. The remainder of the station northward is the Construction Park, laid out for research and training in connection with the various processes associated with the outdoor activities of the Post Office.

POWER SUPPLIES.

Electric power is supplied to all the laboratories from the central block by means of cables in horizontal ducts above the covered ways and above or below the corridors. Three-phase current purchased from the Willesden Borough Council on the maximum demand basis is supplied to the station at 2000 volts and is transformed down to 415 volts in a transformer house situated at the north-east corner of the site, and is brought into the switch house at the lower voltage. Thirteen motor generator sets are installed in the generator room on the ground floor to provide D.C. supplies and for charging batteries. There are also two Duddell alternators and two ringing machines. Most of the supplies in the laboratories are derived from twelve batteries ranging in size from 40 to 1000 ampère hours capacity. The lighting system is fed at 240 volts, but various pressures are, of course, provided for experimental purposes in the laboratories. The main cabling and laboratory wiring has been installed on the basis of a maximum drop between the battery and bench panel on all the main feeds of not more than 2 volts on circuits up to 100 volts and 5 volts on 100-volt circuits and over. For some of the laboratories, however, special batteries have been provided for ensuring a more constant pressure and are charged through rectifiers from the A.C. supply. A battery room is provided, for instance, adjacent to the lines transmission laboratory and is used in connection with repeater research. The batteries in this room are at present objects of research, as the electrolyte of various cells is covered with different kinds of oil in order to determine their relative values as regards preventing acid spray.

In detached buildings the supply cables are led to distribution cases, and distribution is provided from these to the laboratory points in the usual way. In the main research building the laboratories are grouped in eight main divisions, and in each division there is a main distribution frame, which is connected to the main switching point. Where a group of laboratories uses certain supply voltages regularly, leads providing these voltages are permanently connected to the distribution frame. In addition each laboratory is provided with spare feeders, which can be connected to supplies at different voltages as required. Each main feeder terminates on the frame bus-bars in jacks and the outgoing feeders from the frame to the bench panels also end in jacks. By the use of single-way double-ended cords and plugs connection can, therefore, be made from any supply to any bench panel. In the laboratories the cabling is run through floor chases and double-top benches so that convenient access can be gained to the cables at all points. From the distribution frames three pairs of feeds are run to each bench panel and are terminated there on fuse switches with terminals. On each panel there is also a 10-ampère 240-volt A.C. point with an interlocked switch and fuse.

Besides the power supplies there are four junction circuits at each panel. These circuits terminate on terminals at the panel end and on terminals or jacks at the distribution frame. Any panel may therefore be connected to any other panel of its group by using jumper connections or double-ended cords at the distribution frame. From the eight distribution frames circuits are also run to a central board so that panels in different groups may be connected to one another. Three direct lines from the Gladstone telephone exchange, and a 24-pair loaded cable from the trunk exchange, are also terminated at this central board, so that by the use of the inter-laboratory junction it is possible for a direct connection to be established from a bench panel either to Gladstone or to Trunks for experimental purposes.

According to individual needs gas and water supplies have been made available in the various laboratories, and air pressure and rough vacuum, already available in the older labortories, are being extended to the research building as required. Galvanometer brackets have been provided at numerous points.

BOILER PLANT.

The central part of the basement of the central block accommodates the boiler plant, consisting of three heating boilers supplying central heating for the station, a domestic water boiler, and a steam boiler which supplies steam for use in the chemical laboratory, and distilled water for the batteries, &c. In another room in the basement there are liquid air and ice plants and a vacuum pump, which provides the rough vacuum mentioned.

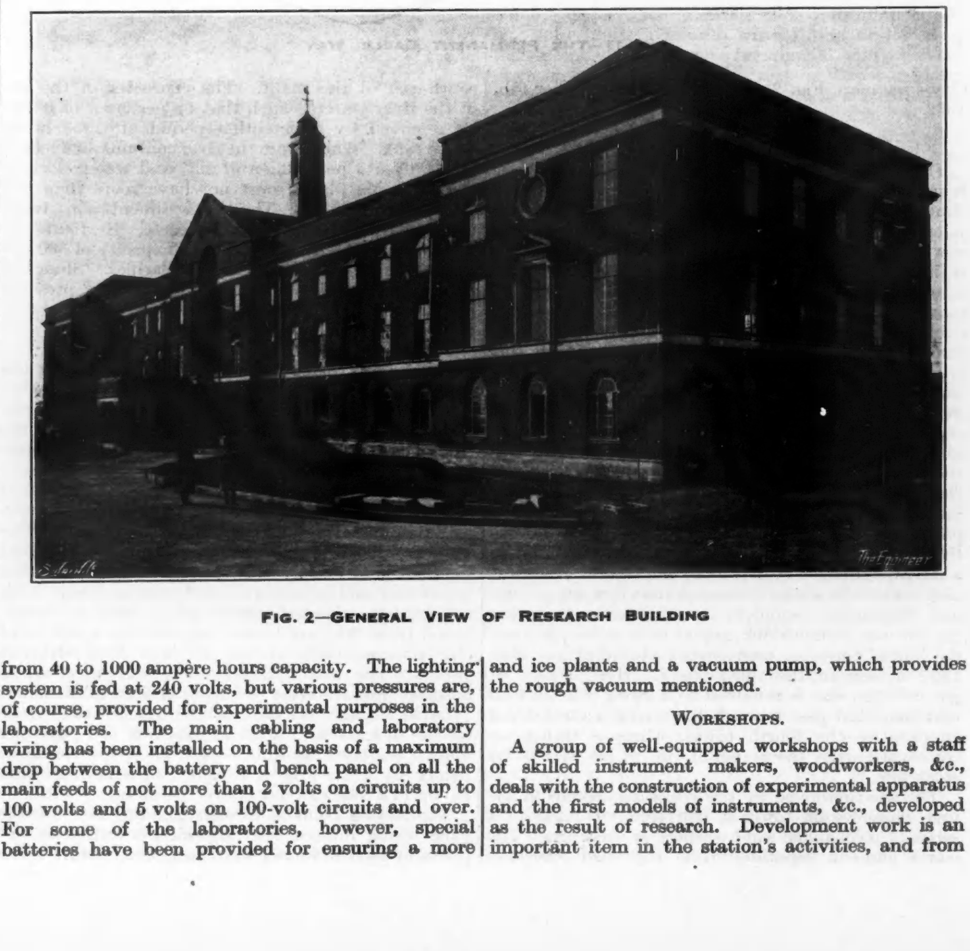


FIG. 2—GENERAL VIEW OF RESEARCH BUILDING

WORKSHOPS.

A group of well-equipped workshops with a staff of skilled instrument makers, woodworkers, &c., deals with the construction of experimental apparatus and the first models of instruments, &c., developed as the result of research. Development work is an important item in the station's activities, and from time to time many ingenious devices have been evolved for telephone and telegraph service. The main block of workshops consists of an assembly shop, coil-winding shop, instrument and machine shop, woodworkers' shop, and millwrights' shop housed in the single building behind the training school. At one end of the adjacent Durability Laboratory, two rooms are set aside for electroplating and paint spray work. A small job workshop equipped with vices and hand tools is also to be found in the main research building. The assembly shop is devoted to the assembly and wiring of apparatus, whilst the manufacture of special transformers and inductances is carried out in the coil-winding shop. The machine shop contains precision bench lathes, horizontal and vertical milling machines, a surface grinder, heavy lathes, a planing machine, a drilling machine, a power saw, gear cutter, and engraving machines. The woodworking shop is also well equipped.

Maintenance work associated with all the shops is carried out by the millwrights' department at the western end of the workshop building. This department is also responsible for heavy forging work and the manufacture of steel apparatus racks of special construction. The equipment includes a forge and a Massey 3 cwt. pneumatic hammer, oxy-acetylene blow-pipes for cutting and welding, and lathes, &c.

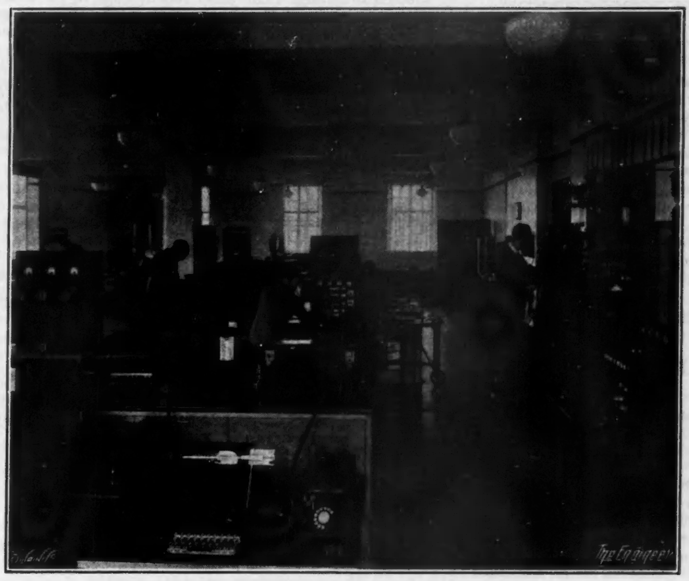


FIG. 3—TELEGRAPH LABORATORY

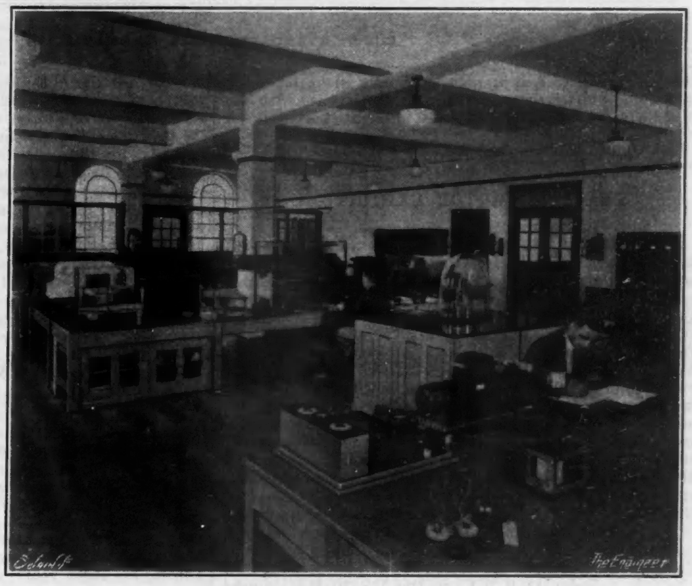


FIG. 4—PHYSICS LABORATORY

CONSTRUCTION PARK.

The construction park, covering an area of some 12,000 square feet, behind the workshop block, is partly used for research work in connection with overhead and underground constructions, and partly for the purpose of training men and youths in the handling of tools and appliances used on outside jobs. A standard pole route serves for training men in the erection of open wire, tree-cutting, staying, &c. Short poles have also been erected for practice in pole climbing, &c. Arrangements have been made for the poles to be armed near ground level, so that classes of men and youths may be given demonstrations of wire jointing, regulating, transposing, and the use of special tools.

Underground equipment, consisting of a multi-way duct route and cast iron pipes with manholes and jointing boxes of the usual type, is used for demonstrations in cabling and jointing operations. This duct route has also recently been used for research work in connection with the accumulation of gas in manholes and for work on cable sheath electrolysis. At one corner of the Park there is a bungalow with different types of internal walls which enable the fixing of apparatus on walls and partitions to be demonstrated.

SCOPE OF THE WORK.

Any attempt to describe all the work carried out at Dollis Hill in a few columns of THE ENGINEER must fall a long way short of actualities. The illustrations Figs. 2 to 4 give a general view of the main building, the telegraph laboratory, and the physical laboratory, while illustrations on page 408 show the chemical laboratory, the lines transmission laboratory, the signalling apparatus and circuits laboratory, and the teleprinter school respectively, but, as indicated in the foregoing description, there are many other departments. Microscopical and spectrographic laboratories are engaged, for instance, on the study of materials used in the construction and maintenance of telephone and telegraph apparatus. Instead of referring to all the laboratories individually, however, it will perhaps be better to endeavour in the remaining space available to mention very briefly some of the most important investigations that are at present being undertaken.

With a view to speeding up the methods of handling telephone calls in trunk circuits, new methods of signalling over telephone lines are being studied. Durability tests, which, in the course of a few months, subject intricate apparatus used in automatic telephone exchanges to wear equivalent to forty years or more of actual operation, under commercial conditions, are constantly carried out to ensure reliability. Investigations in connection with the transmission properties of telephone transmitters, receivers, and the associated circuits, involving voice and ear measurements, are carried out, for the most part, in rooms with various sound-absorbing wall and ceiling treatments, and with metal screens embedded in the walls to prevent electrical interference between one laboratory and another.

A master reference standard of telephone transmission provides a speech standard capable of absolute calibration with which commercial instruments may be compared. Similar reference standards exist in Paris and New York, and enable the standards of telephone transmission to be maintained on an international basis. The effect of all the factors likely to arise on commercial circuits, which are apt to impair the intelligibility of telephone conversations, such as room and line noise, are given attention. Means for rapidly testing the efficiency of the many hundreds of thousands of telephone instruments purchased by the Post Office have been developed, and new methods of measuring the transmission efficiency of subscribers' apparatus and lines are now available. A machine in one part of the station subjects the new types of telephone instrument to the usage it may be expected to receive in the hands of the public, in order to determine probable life and to show up any weak spots.

In the laboratories devoted to the testing of automatic telephone apparatus for durability, all kinds of equipment such as telephone dials, selector switches and relays, are continuously operated until failure occurs, or even to destruction, to enable the engineers to form an idea of how long the apparatus is likely to last.

Much of the research work on telephone lines is at present concentrated on carrier systems in which several separate channels for speech may be obtained on the same wires by the modulation of high-frequency carrier currents. It is well known that the development of such systems has enabled the carrying capacity of expensive submarine cables to be greatly increased, and has led to great economy in plant. In conjunction with this work, investigations are carried out in connection with repeaters used on long-distance telephone circuits.

Important work, as described in our issue of January 27th, 1933, is being done on the teleprinter. Ingenious methods have been devised for measuring the distortion of signals used to work the instrument and for repeating these signals so that the apparatus may be worked over very long lines. The Telex service by which any telephone subscriber may avail himself of teleprinter facilities was developed in these laboratories.

In the Cable Laboratory attention is given mainly to methods of measuring the electrical characteristics of cables and to investigations on methods of locating land and submarine cable faults. A new scheme recently devised has proved of great value in the way of enabling a fault in a submarine cable to be accurately located by means of apparatus connected to two electrodes towed in the sea by the cable ship. The method has been found considerably to reduce the period of delay due to the breakdown and to minimise the time the ship is engaged on the repairs. Problems which arise in connection with damage to telephone cables by corrosion, and those associated with the detection of gas in manholes, are dealt with in the chemical laboratory. For detecting gas a simple and inexpensive device has been devised for the use of men engaged on underground work. Tests to determine the effectiveness of protective coatings on telephone apparatus are in progress in this laboratory, the extreme conditions of climate and weather being simulated in spray chambers containing the specimens under examination.

In the acoustic laboratory tests are made on the acoustic performance of various speech-reproducing apparatus, and to provide the conditions necessary for accurate measurement a silence chamber has been built. Its walls are draped with a great thickness of sound absorbent material in order to prevent reflections of sound which would violate the results of measurements. As indicated in the plan, there is a radio laboratory which is devoted mainly to short and ultra-short wave work.

The total number of people employed or in training at the station often exceeds 600, and as there is no catering establishment capable of dealing with such a number within a mile of Dollis Hill, a large dining-room and kitchen have been provided for a financially self-supporting refreshment club. There is also a spacious lecture hall, which is used for a variety of purposes, such as conferences, and lectures to classes of men attending the station for training.

THE HIGH-SPEED OIL ENGINE.

THERE was a good attendance on Thursday evening last, at King's College, for the first of six lectures by Dr. S. J. Davies, M.I. Mech. E., on "Injection and Combustion in High-speed Oil Engines." The object of this series of special lectures, which will be held on consecutive Thursdays at 5.30 p.m., is to survey the present position of the high-speed oil engine, and to deal with certain sections of oil engine practice and operation which are not covered by existing knowledge of carburetter engines burning petrol or kerosene fuels.

In his introduction Dr. Davies dealt briefly with the history of the high-speed oil engine, which he characterised as a post-war development, largely bound up with the success obtained with the airless injection of fuel. Although this development owed much to Akroyd Stuart and other pioneers, the preliminary step was taken by Vickers in 1910, with the application of airless injection to submarine engines. Such engines, he pointed out, were primarily Diesel engines, and retained the same order of compression and maximum pressure after the charge.

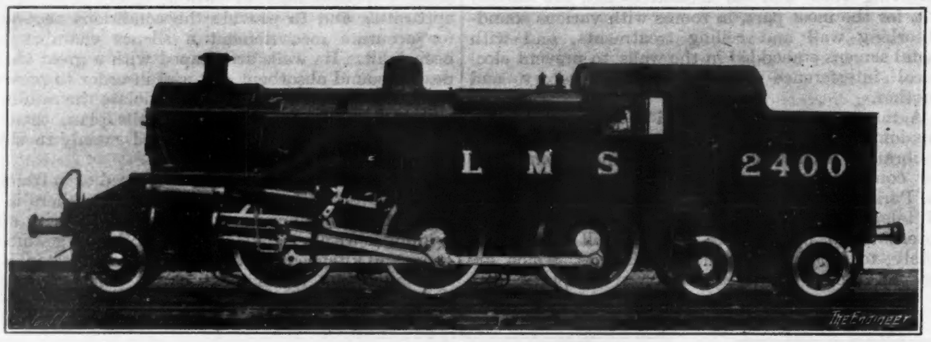
At the end of 1925 there were already in Germany six firms which had engines running at over 1000 r.p.m. and upwards in practical operation. In our own country excellent work was carried out at the Royal Aircraft Establishment, and by Beardmore's, and the presentation of Mr. A. E. L. Chorlton's paper before the Institution of Mechanical Engineers on March, 1926, and Mr. H. B. Taylor's paper before the Institution of Automobile Engineers on November, 1927, marked the beginning of intensive work on high-speed oil engines which has led up to the present satisfactory condition. To-day British-designed engines are produced for both road and rail service, and a wide and useful range of operating experience has been gained, and is available to possible users. Experience with Continental aircraft engines indicates, the lecturer stated, that the service time between overhauls can be materially increased beyond the largest possible to-day with the petrol engine.

THE Lithuanian Government has decided to place with a British company a contract for the installation of two automatic telephone exchanges at Kovno and Memel. It is understood that the contract is of the value of £170,000.

L.M.S. Tank Locomotive.

The accompanying illustration shows the new type of driving cab which is being fitted to the latest standard 2–6–4 tank locomotives (Nos. 2395–2424 inclusive), now in course of construction at the L.M.S. Railway Company's Derby locomotive works.

This cab embodies all-over roof, glass side windows, and a door with drop-light, and will afford increased protection for the driver and fireman, especially when the engine is running bunker first, as is frequently the case with this class, which is used largely for fast suburban services.



L.M.S. Standard 2-6-4, Tank Engine

THE FORD MOTOR EXHIBITION.

From October 12th until October 21st, there was held at the Royal Albert Hall the Ford Motor Exhibition, wherein were shown not only cars, trucks, and lorries, but also various industrial machinery relying for its motive power on Ford engines. The greater part of the floor space of the main hall was taken up with various road vehicles from the tiny 8 H.P. chassis to lorries and vans for all kinds of purposes. We noticed on the Fordson 131½in. truck that that form of springing had been adopted by which several leaves of each spring only come into action when the body is heavily laden, while on some of the smaller cars transverse springing, both at front and rear, had been fitted. In the industrial section, which was for the most part situated in the vestibule, the Ford 8 H.P. marine engine was to be seen. This engine weighs only 220 lb., has a length of 38in., a width of 13in., and a height of 22in., and will run up to speeds greater than 2000 r.p.m. That figure is, however, recommended as a limit. In the industrial field the various Ford productions, from the four-cylinder 14·9 H.P. to the V 8 30 H.P. engine, have been and are being used for a wide variety of purposes. Some typical applications were represented in the Exhibition. For agricultural purposes there was a Fordson tractor with a track measurement of 4ft. and a turning radius of 6ft. A "Planet" rail motor gang trolley, made by F. C. Hibberd and Co., Ltd., of Park Royal, and designed to carry six or seven men, has an 8 H.P. Ford engine. The "Lead Wool" type F C portable compressor set is equipped with the "B" model 24 H.P. engine, which drives another Ford engine with a specially designed head that is thus converted into a compressor. With a piston displacement of 115 cubic feet per minute, the compressor is suitable for pressures up to 100 lb. per square inch. The list could be extended almost indefinitely if all the applications were to be mentioned. Many of the machines using Ford power units have been described from time to time in these columns, and in the future many more no doubt will be so described.

SIXTY YEARS AGO.

A note, reprinted from *Lippincott's Magazine*, in our issue of October 31st, 1873, recalls an almost forgotten page in the history of steam navigation. We know that Fulton, during his visit to Europe, carried out experiments on the Seine on the propulsion of boats by steam, and that, returning to his native country, he constructed the "Clermont," and set her to work on the Hudson in 1807. If, however, the note to which we refer can be trusted, Fulton was only fifteen years of age when James Rumsey laid before Washington the model of a steam-propelled boat which he had conceived. Four years later, namely, in 1784, Rumsey launched his steamboat at Sir John's Run in the presence of Washington and a throng of visitors. Washington, it is stated, expressed the opinion that "the discovery is of vast importance, and may be of the greatest usefulness in our inland navigation." Rumsey adopted the principle which we now call hydraulic propulsion. He propelled his boat "by the reaction of a current squirted through the stern of the boat against the water of the river, the current being pumped by steam." This action was described by *Lippincott's Magazine* as "so primitive, so remote from the principle of the engine now used, that it seems hardly worthy to be connected with the great revolutionary invention of steam travel." Our contemporary was obviously unaware of the fact that Rankine had within the previous two years or so demonstrated the identity in principle of hydraulic propulsion with propulsion by paddle or screw. Rumsey, it would appear, was annoyed by one John Fitch, who, he alleged, frequented his workshop, carried off his ideas, and eventually in 1788 launched a steamboat of his own on the Delaware. It is recorded that Rumsey died in England of apoplexy at a public lecture at which he was explaining his system of propulsion. The story in certain of its aspects is circumstantial. Rumsey was stated to be a bath tender at Berkeley Springs. Berkeley Springs is in West Virginia, and Sir John's Run lies close at hand on the Potomac River. In 1780, the year in which Rumsey showed his model to Washington, the leader of the American forces moved down the Hudson, ostensibly threatening New York, but secretly changed his route, and hurried south through Philadelphia to attack Cornwallis at Yorktown. The surrender of that post, virtually ending the war, came in October, 1781. It is therefore clear that the celebrated general and the humble bath tender were at least within reach of one another in 1780. We can picture Washington listening to Rumsey, much in the same way as Napoleon some fifteen years later was to listen to Fulton while he explained his proposals for assisting the mechanical equipment of the army gathered for the projected attack on Great Britain. By 1784 peace had been made between this country and the revolted American Colonies, and Washington would be at liberty, so far as his military duties were concerned, to attend the launching ceremony on the Potomac. It may be added that Rumsey's contribution to the development of steam navigation—and also Fitch's—is to-day fully accepted by historians of the subject.

OBITUARY.

E. L. MANSERGH.

Civil engineers will deeply regret the loss of Ernest Lawson Mansergh, who died at Woking on Sunday last, October 22nd. Mr. Mansergh, who was born in 1866, was educated at Queenwood College, Hants, and the University College School, London. He began his career as an engineer immediately after leaving school, and was articled in 1884 to his father, the late James Mansergh, F.R.S. During his three years' pupilage he acted as an assistant engineer on the construction of the Hury reservoir of the Stockton and Middlesbrough Water Board. He then joined his father and was later made a partner in the firm of James Mansergh and Sons, which was constituted in 1902. Since the death of James Mansergh in 1905 he had been the senior partner of the firm, in partnership with his brother, Walter L. Mansergh, M. Inst. C.E. He was largely responsible for the design and supervision of the construction of many important works of water supply and sewerage, both in this country and abroad, among which may be mentioned the several reservoirs and the aqueduct in connection with the Elan Valley water supply for the City of Birmingham; the Blackton, Long Newton, and Grassholme reservoirs of the Tees Valley Water Board; the Font reservoir of the Tynemouth Corporation; the Castle Carrock reservoir and works in connection with the Geltsdale supply for the City of Carlisle. He was also consulting engineer to the Fylde Water Board in connection with the Stocks reservoir; the Langthwaite reservoir for the Lancaster Corporation, now in course of construction; and the sewerage and sewage disposal works for the municipality of Colombo, Ceylon. He was a member of the Institution of Civil Engineers and the Institution of Water Engineers, and a founder member of the Association of Consulting Engineers and its chairman for 1920 to 1921.

THE INSTITUTION OF GAS ENGINEERS.

The fifth autumn research meeting of the Institution of Gas Engineers will be held at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1, on Tuesday and Wednesday, November 7th and 8th, 1933. The morning sessions will commence at 10 a.m. and the afternoons at 2.30 p.m. The following Reports will be presented and discussed:—

Fourth Report of the General Research Committee, 1932–33 (Communication No. 75).

Thirty-third Report of the Joint Research Committee of the Institution and Leeds University: Corrosion from Products of Combustion of Gas, Part I., Preliminary Investigations (Communication No. 76).

Third Report of the Liquor Effluents and Ammonia Sub-committee (Communication No. 77).

Twenty-fourth Report of the Refractory Materials Joint Sub-committee (Communication No. 78).

Second Report of the Gasholder Sub-committee (Communication No. 79).

Report on the Behaviour of Cokes in the Open Grate, contributed by Mr. H. J. Hodsman, Dr. E. I. Lloyd, and Mr. F. Bell, Leeds University (Communication No. 80).

Report on Leakage in Horizontal Gas Retorts, contributed by Mr. A. H. Clucas, City of Leeds Gas Department (Communication No. 81).

Tenth Report of the Gas Education Committee, 1932–33 (Communication No. 82).

THE NITRIDING PROCESS.

In a paper on Nitri-cast-iron, prepared by the Sheepbridge Stokes Centrifugal Casting Company, of Chesterfield, and presented at the Scottish Branch of the Institute of British Foundrymen on October 14th, it is stated that very frequently articles for case-hardening require some surfaces to be left soft for subsequent machining operations, the cutting of threads, keyways, &c. The protection of such surfaces from the hardening effect is commonly done by tinning. Pure tin or tin solder is generally used for this purpose. Although such solders melt at a lower temperature than the nitriding temperature, a sufficient amount will adhere by reason of surface tension, and will supply ample protection. In the application of tin, the parts are thoroughly cleaned and a flux of hydrochloric acid (killed) applied. The articles are then dipped into a bath of molten solder or tin and kept there sufficient time for the tin to adhere. The excess of tin can be shaken or brushed off with a wire brush on removal from the bath.

Nickel plating to a depth of 0·0005in. has been found effective in preventing the nitriding. Experiments have been made with protective paints. Positive results have been obtained with paints made up of stannous or stannic oxides. These compounds decompose in the nitriding furnace to form tin. Another protective paint consists of powdered aluminium and sodium silicate. This is applied with a brush to the surfaces to be protected and then allowed to dry. A hard coating is formed which can be removed after nitrarding by boiling the articles followed by scratch brushing. The most recent type of protective paint consists essentially of a mixture of finely powdered lead and tin suspended in an oily vehicle of animal oils. This can be applied to the articles by means of a brush or spray pistol. The fine coating of powdered lead and tin thus obtained on the surfaces melts at the nitriding temperature and thus exercises the same function as the solder applied in the manner previously described.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

STEEL RAILWAY SLEEPERS.

No. 500—1933. This is a specification for steel sleepers for flat bottom railway rails, and has been prepared by a committee representative of both the manufacturers and users.

The requirements of the specification and the sections standardised for the sleeper plates have been adopted after the most careful consideration of existing practice, both in this country and throughout the Empire. In so far as the design of the sleepers is concerned, the Committee has limited the specification to a series of standard sleeper plates from which the sleepers are to be pressed. Beyond this point the Committee did not consider it desirable to proceed, since a comprehensive review of present-day practice indicated that the variety of conditions under which the sleepers were used, and the diversity of opinion which existed in regard to the shape of the finished sleeper made it impracticable to prepare any standard requirements likely to meet with a reasonable measure of general acceptance. Similar considerations led the Committee to omit any requirements as to the method of fastening the rails to the sleepers.

The series of sleeper plates comprises ten basic sections, from 9½in. to 14in. in width. By opening or closing the rolls it is possible, however, to modify the thicknesses of the basic sections, thereby providing a total range of twenty-eight sizes in weights from 7½ lb. to 23 lb. per foot, a range which it is considered is adequate for all normal requirements and gauges. In the past quite fifty sections of sleeper plates have been in common use, which, though varying from each other to a small extent only, have necessitated separate rolls. It is believed that the reduction in the number of rolls will eventually lead to economy in manufacture.

The clauses of the specification detail requirements relating to the quality and physical properties of the steel, with particulars as to the manner of conducting the mechanical tests, the procedure to be followed in regard to inspection, both during and after manufacture, and requirements as to the coating composition and permissible deviation from standard weights.

The specification is primarily intended for sleepers for use with flat bottom rails, and it is for such use that the sleeper plates have been designed. Many of the requirements of the specification itself will, however, be found to be equally applicable for the manufacture of sleepers for bull-headed rails.

Plastics.—On November 8th, the London and Midland Section of the Institute of the Plastic Industry will visit Alfred Herbert, Ltd., Coventry, to see a demonstration of machines suitable for the production of moulds for plastic materials. The machines will be shown in operation on moulds and their parts. The demonstration will begin about 11 a.m., and luncheon will be served afterwards.

Institute of Fuel.—The seventh annual dinner of the Institute of Fuel was held on Wednesday, October 18th, at the Connaught Rooms, London, and attended by over 500 members and guests. In the absence through indisposition of the Minister of Transport, Lieut.-Colonel J. Colville, Secretary to the Department of Overseas Trade, proposed the toast of "The Institute." Beginning in lighter vein he later referred to the high value which the Government attached to the work of the Institute. The President, Sir William J. Larke, responded, and later presented to Sir John Cadman the Melchett Medal for research of an outstanding character involving the scientific preparation and development of the use of fuel. The speeches, which were all commendably short and of a high standard, were brought to a close when Mr. Loughnan St.L. Pendred replied to the toast of "The Visitors," proposed by Mr. R. D. Kitson. Members and guests then adjourned to the reception rooms for dancing. Later there was a highly enjoyable cabaret show.

Railway and Road Matters.

It is good news to hear that the London and North-Eastern has returned thirty-five locomotives to traffic from those that were withdrawn owing to want of business.

In order to make our record as to the Little Salkeld fatal accident of July 10th complete, we may say that in view of the porter-signalman's acquittal at the Carlisle Assizes on the charge of manslaughter, the coroner's jury on October 17th, returned a verdict of "Accidental death" in the case of the driver killed in that accident.

This month witnesses the diamond jubilee of the sleeping car on the West Coast route from Euston to Scotland, on which service the first car was introduced in October, 1873. The pioneer "sleeper" of sixty years ago was built at the London and North-Western Railway works at Wolverton, Bucks. It was only 33ft. long, compared with the 65ft. of the latest L.M.S. type.

During last year there was only one accident to a passenger train in which there was a loss of life. That was the derailment of Great Bridgeford in which four passengers were killed. There was also a collision between two empty carriage trains and the derailment of an engine. In the former a guard and in the latter a driver was killed. The record, up to now, of the present year is much less satisfactory, as there have been two fatal passenger train accidents, in one of which four passengers lost their lives, and another was killed in the second. There have also been four further accidents in which a total of eight servants have been killed.

At a meeting of the London County Council, held on Tuesday, October 24th, the proposal that Waterloo Bridge should be widened by corbelling out, in accordance with a design which has been prepared by Mr. G. Topham Forrest, the Architect to the Council, was approved. The design has been prepared in collaboration with Messrs. Rendel, Palmer and Tritton, of Westminster, the consulting engineers for the scheme, and has now been approved by the Royal Fine Arts Commission. Only the upper part of the bridge is to be widened, and the design shows that there will be the least possible alteration in the appearance of the bridge.

One of the many useful activities of the late Everard R. Calthrop, besides his great work on the Barsi Light Railway, was the building of the Leek and Manifold on the borders of Staffordshire and Derbyshire. That railway was subsequently taken over by the North Staffordshire, and so became part, later, of the London, Midland and Scottish system. Because it did not pay, the line was to be abandoned, but appeals from rambling societies, particularly those in Manchester, led to that proposal being withdrawn. Satisfaction is now expressed that the winter time-tables provide for a continuance of the train service, and the railway authorities have promised that if the line should be closed against traffic, the track should remain as a path.

If anyone who had occasion to spend some time in Carlisle Station in pre-grouping days, had a similar experience now, he might possibly be struck by the absence of the former variety in the types and colouring of the locomotives to be seen there. To-day there are only two companies using Carlisle Station—the London, Midland and Scottish and the London and North-Eastern. Just over ten years ago there were seven—the London and North-Western and Caledonian, who were the owning companies, and the Midland, North-Eastern, North British, Glasgow and South-Western, and the Maryport and Carlisle. Almost the same thing could be said of York. Formerly there were the North-Eastern, Great Northern, Midland, Lancashire and Yorkshire, and the Great Eastern; to-day only the L.N.E.R. and the L.M. and S.

According to the Railway Returns for 1932, one of the grouped companies—evidently the London, Midland and Scottish—has had its length of line remeasured, and the total figures, for all the railways, for the years 1927 to 1931, have had to be revised. The total length of road, for all British railways on December 31st, 1932, was 20,383 miles, a decrease of 12 miles. Expressed as single track, the total mileage of running line was 37,217 miles, an increase of 54 miles, and of sidings 15,683 miles, an increase of 47 miles. The length of new lines, widenings, &c., authorised for construction but not open for traffic, was 478 miles, of which 103 miles were for new lines and 375 miles for widenings. The mileage of track renewed was 1245½, as compared with 1359½ miles in 1931. The tonnage of the rails used was 201,444 as against 213,199 in 1931, and the number of sleepers was 3,910,793, as compared with 4,330,092.

The last occasion on which we referred to the railway traffic returns was on October 6th, when we dealt with those for the thirty-eighth week. On that occasion the receipts from passenger traffic showed useful increases, but less than those recorded in the summer. Whilst acknowledging that the abnormally fine weather has greatly contributed to this, the benefit mainly has come from the summer return tickets. We have, however, claimed that the increases those tickets have brought are more apparent than real, as, when a passenger takes a return ticket instead of a single, the company will be short of the companion single ticket for his return journey, besides getting only 2d. per mile for the double journey instead of two single trips at 1¼d. per mile each. It was obvious that as long as the holiday season was in being the loss on the single ticket for the return journey would be compensated for by other passengers taking the "summer" return, but as soon as the traffic slacked off the loss of the single ticket for the return would be noticed. That that is so is shown by the L.M.S. in the forty-first week being £9000 down; the G.W., L. and N.E., and Southern have increases of £6000, £5000, and £7000 respectively, as against £11,000, £13,000, and £14,000; and the L.M.S. a £13,000 increase a fortnight previously. In drawing attention to these facts we would say that we do so for fear it should be thought that there is a falling off in the passenger traffic; such, in our opinion, is not the case. There can, however, be no misapprehension over the goods traffic, as for the week in question the L.M.S. and L. and N.E. each had an increase of £33,000, the G.W. one of £14,000, and the Southern £2500.

Notes and Memoranda.

Some experiments carried out in America show that ozone is as effective in producing "knocking" in petrol engines as is lead tetra-ethyl in reducing it.

The official report on the explosion which occurred in the West Cannock coal mine, Staffs., on May 16th last, states that it was caused by an electric spark from a signal bell.

The new paper mill of the Blandin Paper Company in America has no windows, and both ventilation and light are provided artificially. The building measures 320ft. by 50ft., and houses a 156in. machine, which requires the circulation of 12,000 cubic feet of air at a temperature of 70 deg. to carry away the vapour produced in drying the paper. The latent heat of this vapour is recovered and used for heating the building.

Treatment of heavy oil engine cooling water in accordance with its chemical analysis before it enters the jackets is the best procedure, states Mr. L. O. Newton, who, at a meeting of the Diesel Engine Users Association, pointed out that though the addition of chemicals during circulation may prevent the deposition of hard scale, it turns the lime and salts contained in the water to soft sludge. This sludge must be removed; otherwise the passages will soon become choked.

Controversy as to the relative merits of cast iron and welded steel construction frequently overlooks the question of vibration, or its absorption, according to Mr. J. H. Godfrey, in the *Machinist*. According to experiments he has seen quoted, cast iron absorbs vibration twelve times better than steel plate and twenty times better than aluminium. The same tests indicated that the common variety of grey iron was better as a base for machinery in general, than the irons with alloys that gave them added strength. These alloy irons were not as good from the anti-vibration point of view.

A recent publication of the U.S. Geological Survey, concerning the Ashland coalfield in Montana, states that there are more than seventeen seams and an estimated resource of almost eleven billion tons of coal, most of it in five beds with local names, all in the Tongue River member of the Fort Union formation, which is an Eocene measure. All the coal occurs in about 875ft. of strata. Everywhere the outcrops are burned, forming a hard slag or porcellanite. Beds 20ft. to 25ft. thick occur, and persist at that thickness over areas of several square miles. Outcrops of coal beds 10ft. thick are common. No analyses of the coal are given.

The tensile properties and ductility of steel are not impaired by a tin content up to a maximum of 0·6 per cent., the yield point and the maximum stress being, in fact, slightly increased. On the other hand, if the amount of tin exceeds, at the most, 0·2 per cent., the impact value in the normalised condition is greatly reduced. In the heat-treated state this embrittlement to notched-bar tests occurs at still lower tin contents. The effect is much more detrimental if the steels are tempered at a low temperature after quenching, and if they are allowed to cool slowly through the temperature range from 400 deg. to 200 deg. Cent. after tempering. The ill-effect of tin upon the impact strength of these steels is minimised by quenching after a full tempering at about 620 deg. Cent. These effects bear a similarity to the "temper-brittleness" to be found in certain nickel-chrome steels. There is indirect evidence that the embrittlement may be due to thin films of carbide which are formed at the grain boundaries. If this be so, it may indicate that tin is a more objectionable constituent of high-carbon steels than of the lower-carbon material.

The Pennsylvania State College has been making experiments on the use of coal dust as a fertiliser in the growing of wheat, oats, and corn, and has come to the following conclusions:—The coal dust obtained from the Pittsburgh Coal Company contained no appreciable quantity of any important plant nutrient. It tended to increase soil acidity slightly and to decrease nitrification. Used as a surface dressing or mixed into the soil, it tended to lower the temperature of the soil and delay germination. When used as a surface covering ¼in. to ⅜in. deep it decreased evaporation materially, hence in dry years it might increase the yield materially, while in moist years it might have no effect. After it has been used as a surface dressing, ploughing and planting operations inevitably will incorporate it in the soil. As it has been shown that the product decreases nitrification and increases acidity, the cumulative effect of its use year after year might be expected to be injurious. It does not inhibit weed growth; therefore it would not be feasible for use on any cultivated crop, because cultivation would mix it with the soil and nullify any possible mulching tendencies. Its use in plant production appears undesirable.

Some tests carried out by the United States Bureau of Standards show that stoves for house heating should be spaced not less than 24in. from walls faced with wood, and the smoke pipes not less than 12in. below wood joists or ceilings. If bright sheet metal is applied to the walls, the spacing can be decreased to 12in. Similarly, plastered wood stud partitions, while requiring a spacing of not less than 18in. when unprotected, will be safe if only 9in. from stoves if the area exposed is covered with bright metal. Bright metal, such as galvanised iron, was found considerably more effective than black iron, since it reflects more of the radiant heat. Tests indicated that a ventilated air space of not less than 4in. all around the pipe, or of 2in. if filled with insulation, is necessary where smoke pipes pass through combustible partitions. If stoves are without ashpits, or if ashpits are heated to near redness, an air space of 5in. or more should be provided between the stove and a wood floor and the latter covered with incombustible insulation ¼in. thick under sheet metal. If the fire-box rests directly on the floor, the latter should be of incombustible materials throughout for the area surrounding the stove. For this condition temperatures high enough to cause ignition of wood were transmitted through a 4in. brick base. This explains the frequent occurrence of fires caused by ignition of wood forms left in place under brick or concrete arches supporting fire-places.

Miscellanea.

The Leipzig International Samples Fair will be held from March 4th to 10th, 1934.

A factory for the manufacture of paper-making machinery is to be put up adjacent to Hadfield's foundry in Sheffield.

The recently formed Copper Development Association has secured the services of Mr. Basil Marriott as its architectural adviser.

The estimated cost of the proposed cantilever bridge at Howrah is £1,500,000. It will have a 71ft. roadway, with tram lines and two 15ft. footways.

It is stated that by using oil instead of coal as fuel at its London headquarters, the National Institute for the Blind has saved £1231 during the past four years.

The turbo-blowers for the new Corby steel works, in Northamptonshire, of Stewarts and Lloyds, are to be made by Richardsons, Westgarth and Co., of West Hartlepool.

The twelve hollow-forged steam drums for the boilers necessitated by the re-engining of the liners "Alcantara" and "Asturia" are being made by Thos. Firth and John Brown, of Sheffield.

A brick-making works for using up oil shale refuse is to be put up at the Pumpherston Works, Mid-Calder. It is said that a process for the manufacture of a durable brick has been discovered.

The dismantling of the electric power station at Port Dundas, Glasgow, has been started. The station was erected in 1899, and with the completion of the grid system has become superfluous.

Public utility plants and plants operated in connection with manufacturing establishments and with mines and quarries in the United States have a combined rating in excess of 44,000,000 kW, and the total motor horse-power mounts up to a figure almost as large.

The Scotswood suspension bridge across the Tyne has been temporarily closed for the adjustment of the expansion plates at the ends of the span. Councillor J. Clydesdale says that the bridge, which is 100 years old, will have to be replaced within the next twenty years.

It is said that the steamer "Villa Selgas," which has been reported as foundered off the Spanish coast, is the original "John Bowes," the first iron screw collier, built eighty-one years ago at Palmer's Shipbuilding Yard, Jarrow-on-Tyne. The vessel was constantly in service.

On October 1st the first electric train was run between Stockholm and Malmö, electrification work on all sections of this important Government-owned line having been completed several months before the date fixed in the original programme. Next spring, when a new time-table comes into force, travellers will be able to do this distance in at least two hours less than by steam train.

At an informal meeting of the Junior Institution of Engineers on October 20th, Mr. A. C. Judd said that about eighty air-lift pumps were at work in the London area in which the lift was between 200ft. and 350ft., the quantity raised anything from 1000 to 20,000 gallons per hour, the bore-hole diameters varying from 6in. to 24in., and the depths usually between 500ft. to 700ft.

It is stated that the helio-station and the helio-laboratory of the All-Union Academy of Science, U.S.S.R., have elaborated a scheme for the mass production of solar apparatus. The design has been completed of a solar boiler of 5 square metres dimension, giving a million calories a year. Designs have also been made for a compound apparatus to work 200 days on solar energy and 165 days on fuel.

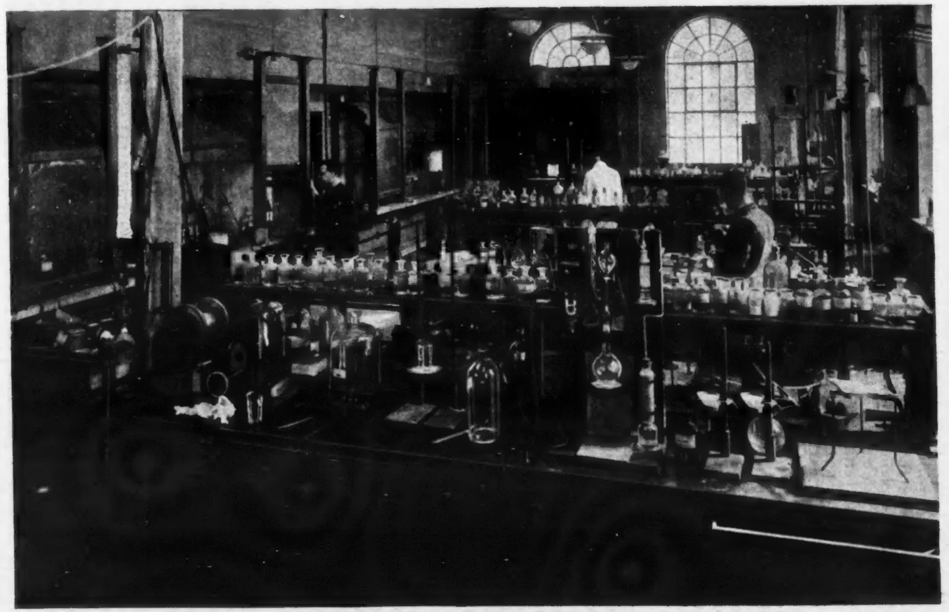
The work of the Sub-committee set up by the Institution of Electrical Engineers to inquire into electrical interference with broadcasting, indicates that devices for the suppression of interference from many items of electrical plant, particularly domestic appliances, could be incorporated in future designs at a reasonable cost. Further investigation is necessary on some of the larger items of plant, and tests of a quantitative nature are being carried out by the British Electrical and Allied Industries Research Association on such items.

In the course of the interim report of the Inter-Departmental Home-grown Timber Committee, recently issued, it is stated that the area classified as woodland in Great Britain is nearly 3,000,000 acres, of which some 300,000 acres are under State management, including 230,000 acres of young plantations made by the Forestry Commission since 1920. Approximately, 2,700,000 acres are private property. Fellings made during the war or immediately after accounted for about 450,000 acres, and included nearly all the best stands of ripe coniferous timber. Part of this area is still derelict. The remaining woodlands include a large extent of coppice and scrub, for which there is little demand.

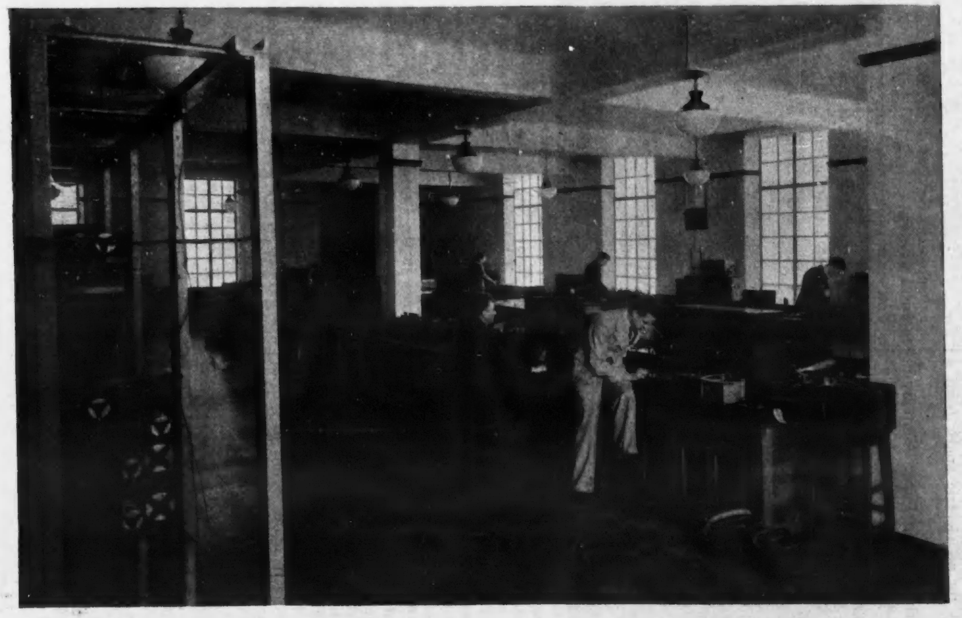
According to the *Iron and Coal Trades' Review*, the Coltness Iron Company, Ltd., telephoned the Harland Engineering Company, Ltd., on Monday morning, inquiring for a pump set for urgent mine work. The set offered for the particular duty was the "MOB 6" pump, to deliver 200 gallons per minute against a 500ft. head, coupled to a 45 H.P., 500-volt motor, complete with a fabricated steel bed. Negotiations proceeded until 4.30 on the day mentioned, when definite instructions were given to the Harland Engineering Company to manufacture for delivery the following day. The drawing-office information was cleared in one hour, and this included drawing up a fabricated bedplate for the set. A stock motor was tested to determine its suitability for the work. The pump was built complete from its foundation, which process included the filing of impellers and guide ports to gauge as well as balancing the former; also the bedplate was manufactured, machined, drilled, and ready for assembly in time to match up with the completion of the pump. The set, complete with valves and gauges, was finished and ready for despatch by 2.30 p.m. on Tuesday, a total manufacturing time of twenty-two hours. It was then despatched to the client's colliery by motor lorry.

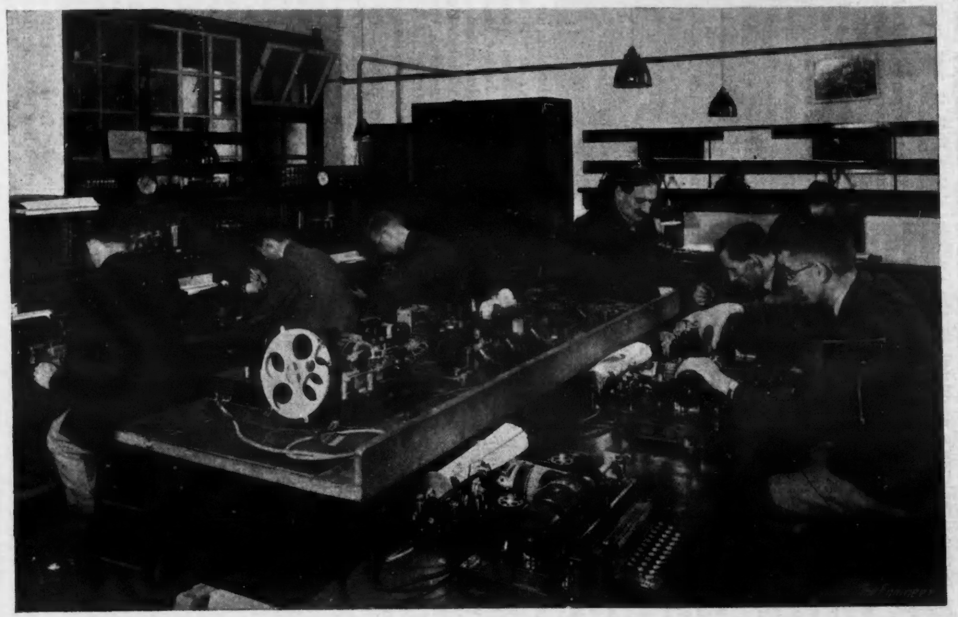
POST OFFICE ENGINEERING RESEARCH STATION, DOLLIS HILL

(For description see page 404.)



Above:—Chemical Laboratory
Below:—Signalling Apparatus Laboratory

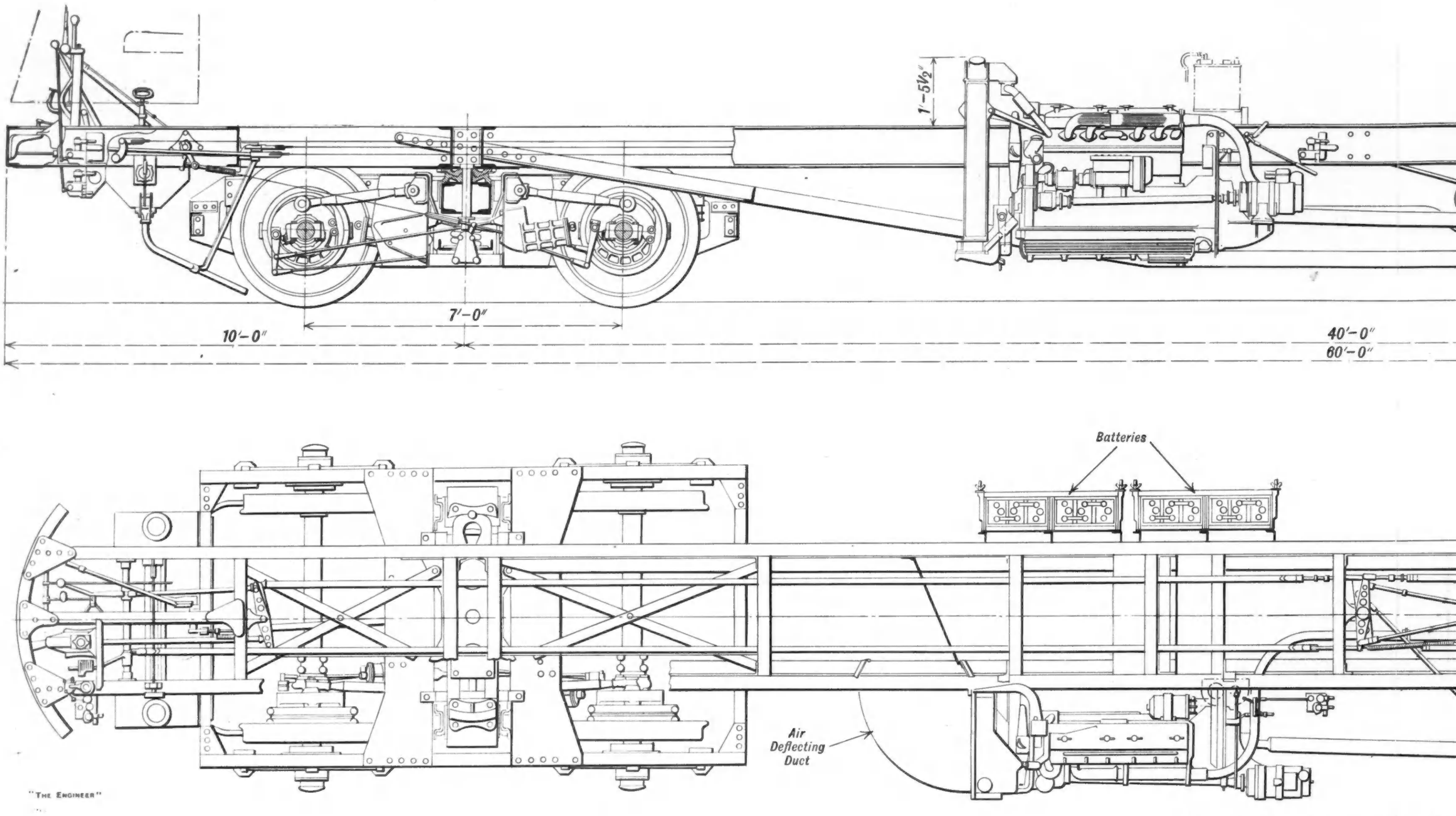




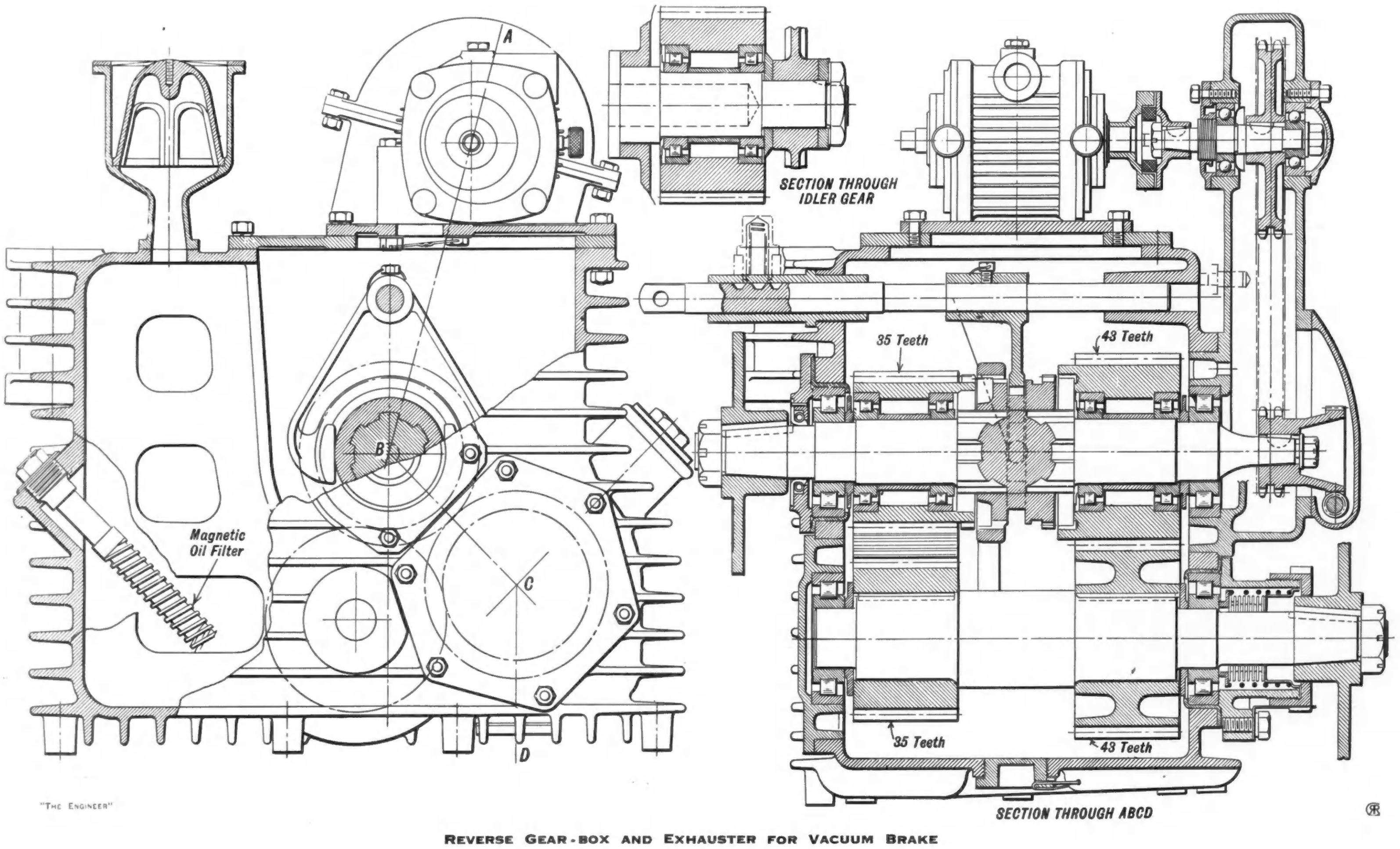
Above:—Lines Transmission Laboratory
Below:—Teleprinter School

CHASSIS OF 130 H.P. OIL ENGINE-DRIVEN RAILCAR

HARDY MOTORS, LTD., SOUT


1'-5½"
7'-0"
10'-0"
40'-0"
60'-0"
Batteries
Air Deflecting Duct
"The Engineer"

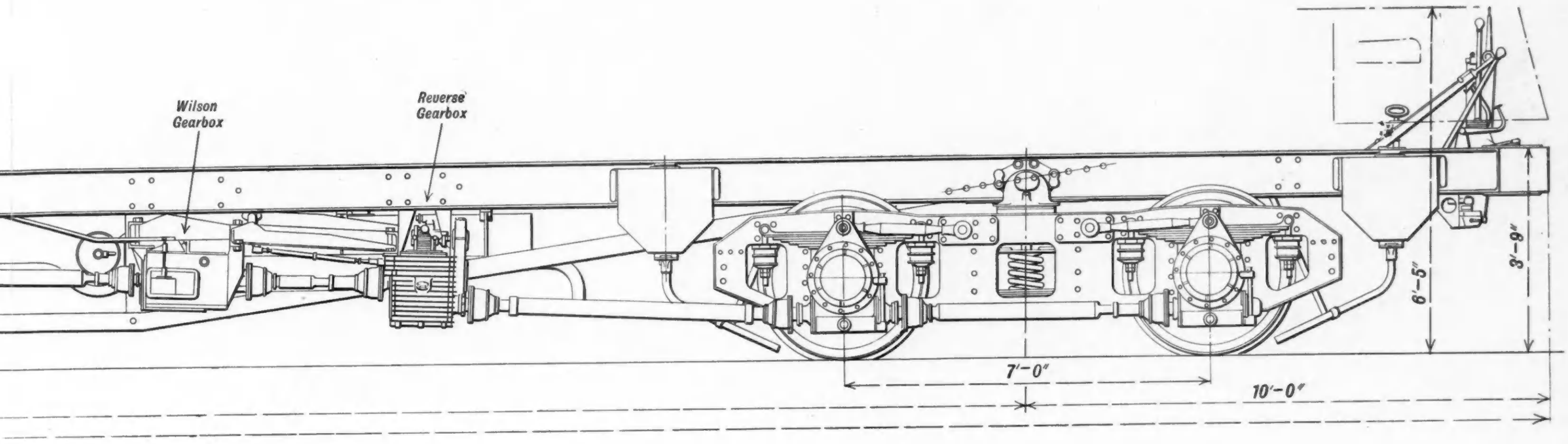
General Arrangement of Com

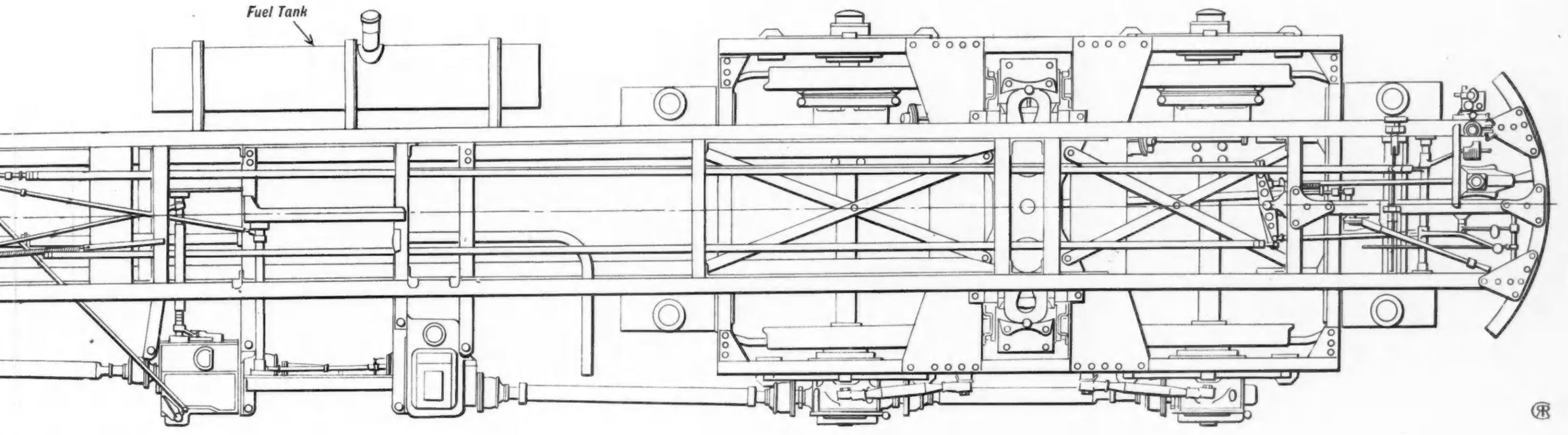

A
B
C
D
Section Through Idler Gear
Magnetic Oil Filter
35 Teeth
43 Teeth
35 Teeth
43 Teeth
Section Through ABCD
"The Engineer"

Reverse Gear-box and Exhauster for Vacuum Brake

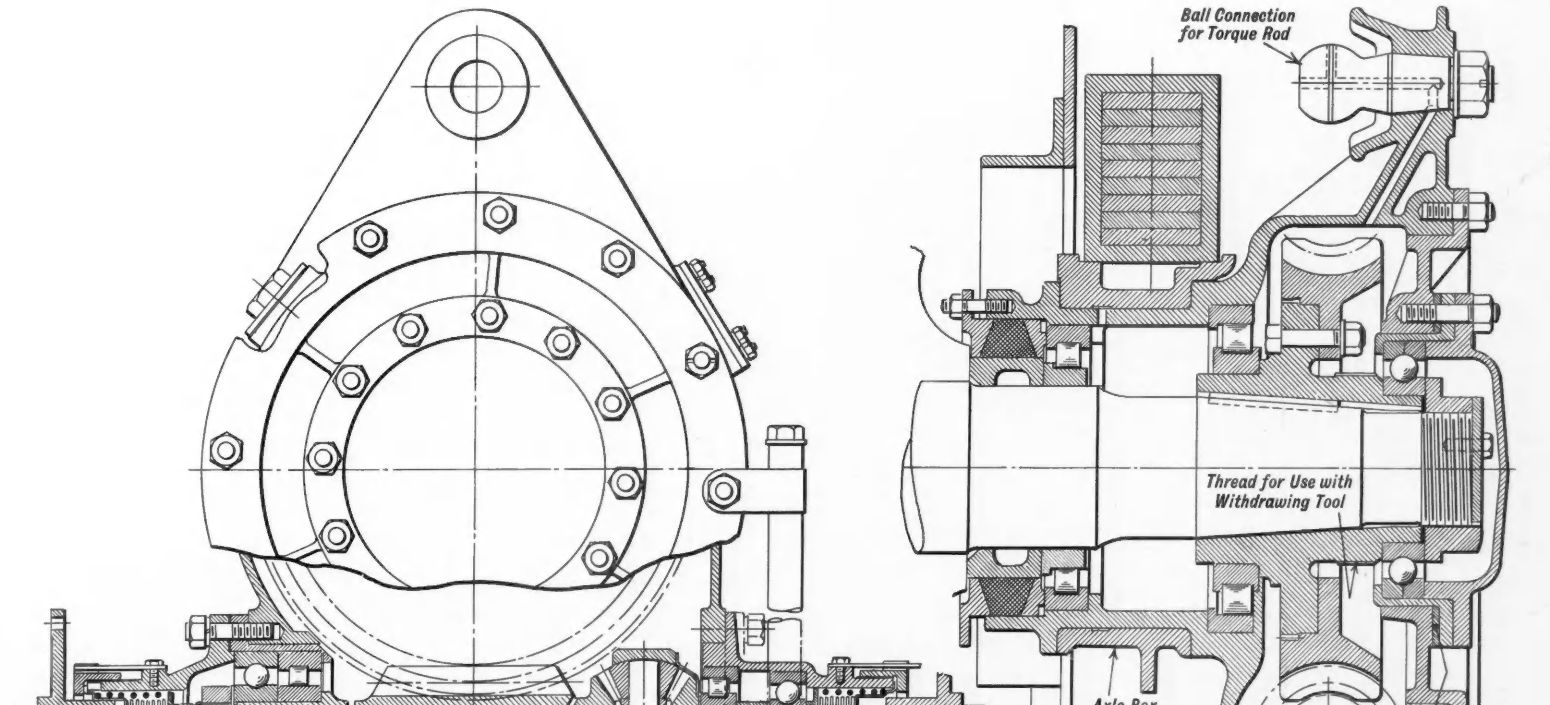
AR FOR SERVICE ON GREAT WESTERN RAILWAY

SOUTHALL, ENGINEERS


Wilson Gearbox
Reverse Gearbox
6'-5"
3'-9"
7'-0"
10'-0"



OF COMPLETE CHASSIS


Ball Connection for Torque Rod
Thread for Use with Withdrawing Tool
Axle Box Sleeve
Axle Box
Shim for Adjusting Mesh of Worm & Wheel

"THE ENGINEER"

WORM DRIVE AND AXLE-BOX ASSEMBLY

The Engineer

OCTOBER 27, 1933.
Vol. CLVI. No. 4059

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The Metallurgist.

THE OCTOBER NUMBER OF
THE METALLURGICAL SUPPLEMENT TO
"THE ENGINEER" ACCOMPANIES THIS ISSUE.

DEATH.

On October 24th, 1933, at 51, Crystal Palace Park Road, Sydenham, Henry Coke Powel, M. Inst. C.E., M.I. Mech. E., M. Soc. C.E. (France), in his 91st year.

EXCAVATION IN UNSTABLE GROUND.

Sir Henry Japp's paper descriptive of two new methods of carrying out excavation in "bad" ground, which was read before the British Section of the Société des Ingénieurs Civils de France at the Institution of Civil Engineers on Tuesday last, is an important contribution to engineering knowledge. We print the text of the first part of it on another page of this issue, and shall present the remainder next week. The difficulties with which engineers and contractors are confronted in excavating for deep foundations in unstable ground have at all times taxed their ingenuity. Necessity is the mother of invention. It is now more than one hundred years since the versatile Lord Cochrane patented the use of compressed air for shaft sinking and tunnelling in water-bearing strata. Little use was, however, made of the method until it was employed, about 1872, in constructing the foundation piers of the first Brooklyn Bridge, and it was not until 1879 that compressed air was used in tunnelling at Antwerp. In the same year compressed air was employed in driving the first tunnel under the river Hudson at New York and a little later came the first application of air to the building of quay wall foundations on a large scale. The diving bell, involving the employment of compressed air, as used in constructing the foundations of marine and other works, is, of course, of much greater antiquity than the air lock and its applications. In sinking deep shafts through alluvial ground the freezing process, first introduced about forty years ago, has often been employed, but more frequently abroad than in this country. It is a useful, although costly, method of sinking in situations where the amount of water expected to be met is too great to be dealt with by pumping and the pressures are too high to be balanced by compressed air. A few deep mine shafts have been sunk in this country by the freezing process and an outstanding example of such work, the sinking of two shafts in alluvial ground to form the intake and discharge openings for the condensing water tunnels of the Swansea super electric power station, has recently been described and illustrated in this journal.[*] One of these shafts was frozen to a depth of 172ft. below the coping of the walls of the King's Dock at Swansea. The freezing process has, however, as Sir Henry Japp points out, proved unsatisfactory when applied to tunnel driving, and compressed air working has hitherto afforded the most suitable means of overcoming the difficulties of tunnelling in quicksand. The limit of safe and economical working under pressure in tunnelling or shaft sinking is represented by a water head which does not greatly exceed 100ft. Some of the shafts sunk for the concrete core wall of the Silent Valley reservoir dam in the Mourne Mountains a few years ago were, however, successfully carried down to a depth of over 200ft. in water-bearing strata, the head of water in the surrounding saturated strata being reduced by pumping so that the air pressure within the working chamber seldom exceeded about 35 lb. per square inch above the atmosphere.

One of the two processes recently introduced to this country and described by Sir Henry Japp is likely to prove of great benefit to those responsible for dock construction where there is an underlying bed of dense water-bearing sand under high water pressure below the point of excavation. Until recently this condition has usually been met by the expensive process of sinking concrete monoliths by open dredging. The new method is the water lowering process, by means of which the water level in the strata is reduced by pumping in several tube wells of small diameter. Although we refer to this as a new process—having been introduced to this country only within the past two or three years—the system in one form or another has been employed abroad for nearly fifteen years. As now used in this country it was developed in Germany and in the United States of America, but it originated in the "step-wise" system of tube well pumping. The original method has been extensively employed in Germany, Holland, and Belgium in excavating the foundations for dry and wet docks in water-bearing sands. The later development, first employed in Germany in 1927, consists in sinking pipes from the ground surface to the full depth required and suspending in these pipes centrifugal pumps to discharge the water. The first application of the system in this country was in connection with the excavation of the dry dock for the Southern Railway Company, which was opened by H.M. the King in July last. We gave a brief account of the tube wells in our description of the dock works published at the time (July 14th, 1933) and a more detailed description will be found in Sir Henry's paper. At Southampton the pressure of artesian water in the bed of sand and pebbles, underlying at no great depth the clay in which the walls and invert of the dry dock are founded, represented a head of water of 94ft. at the underside of the invert of the dock. This would have resulted, if excavation had proceeded without lowering the artesian water, in such upward pressure on the layer of sandy clay under the invert as would have caused serious "blows." The only alternative would have been to construct a considerable part both of the walls and invert by the monolith system at a greatly enhanced expenditure. More recently the water lowering process has been used in the construction of the entrance lock at the new Grimsby Fish Dock, where water-bearing strata under artesian pressure lie immediately beneath the impervious clay in which the lock walls and floor are founded. The second process described by Sir Henry Japp is the chemical consolidation of water-bearing strata developed by Dr. Joosten in Germany during his management of certain potassium and salt mines at Nordhausen. He found that by impregnating the brine-charged ground in the mines with sodium silicate both the soil and the liquid were made into a hard mass by the chemical combination of the sodium silicate with the brine. Patents covering the application of the method to the solidification of loose soils were taken out in 1925 and 1926. The great advantage of this process is that it is possible to transform loose sandy gravel in a shaft or tunnel heading into a permanent solid layer impervious to water. The consolidation or petrification takes place at once, the sand and ballast being converted into a material resembling a sandstone or conglomerate. Small injection pipes are driven into the strata; a solution of sodium silicate is first pumped through the pipe, followed by an injection of calcium chloride solution, the pipe being withdrawn by short steps after each pair of injections. The system was first applied in this country in April, 1933, when John Mowlem and Co., Ltd., employed it on a trial length of the sewer diversion tunnel at the Bank-Monument Station of the Underground Electric Railways. Since then it has been used in England on several tunnel works, the underpinning of walls, and the consolidation of foundations.

Each of these processes is likely to be of great value in the carrying out of public works. The chemical consolidation process appears to possess certain advantages when compared with existing methods of forcing cement grout under pressure into the interstices of sand or gravel. For instance, in the cementation process the cement is likely to be segregated and left to set in hard globular lumps without reaching the fine interstices and accomplishing its intended purpose. The cost of the plant required for operating the chemical process is relatively insignificant, the principal expense being that of the chemical ingredients used. In this respect chemical consolidation seems to compare very favourably with consolidation by freezing, for which elaborate and expensive plant is required and which involves continuous and costly working of the freezing operations. Moreover, the chemical process seems to be capable of successful application in tunnelling operations where working under compressed air would otherwise be unavoidable, and Sir Henry gives examples of such conditions. One application of the chemical process, which seems to us to be obvious, is in the carrying out of deep foundation work and underpinning in water-bearing strata in proximity to buildings of outstanding importance where the abstraction of water from the underlying sands might result in movement of the foundations of the existing structures. We have in mind the conditions which obtain in the neighbourhood of St. Paul's Cathedral, the safety of which in connection with deep excavations in its immediate surroundings is a cause of constant anxiety to those responsible for the building. The advantages and economy of the water lowering process have been well proved in the case of the Southampton dry dock, and it is unlikely that such a work could have been constructed in the short space of two years had not Mr. Wentworth-Sheilds and the responsible contractors had the courage to take advantage of a system of working hitherto untried in this country.

Road Accidents.

Each year upon the roads of England, Scotland, and Wales there are killed as the result of accidents nearly 7000 persons. For every person killed about thirty are injured in some degree. Since the first records were taken, each year, with two or three exceptions, has shown a greater number killed or injured than that which preceded it. Little or no comfort is to be gained by reckoning the figures upon a vehicle-mileage basis, for although estimates prepared on such a plan are necessarily unreliable from the lack of important data, they suggest the existence of a figure constant at about three fatalities per 10 million vehicle miles. Though that figure may have a comforting sound to each individual driver, it means for the community at large a steady increase in the "toll of the road" in accordance with the increase in the number of vehicles in use from year to year. In 1930 the Road Act was passed, defining, among other matters, new road offences and bringing into action the mobile police. At the same time, the speed limit for private cars was abolished and raised to 30 m.p.h. for lorries and coaches. As a result of these reforms, it was hoped that an improvement in the accidents returns might be brought about. Yet, though fatalities have fallen from 7305 in 1930 to 6691 in 1931 and 6667 in 1932, it is questionable whether these figures represent a real improvement, or whether the reduction has been brought about by a lesser use of the road as a consequence of the depression. In London, alas! the returns for the quarter ended last September show a large and alarming increase over the corresponding figures for the preceding year in both deaths and injuries.

That the present position cannot be tolerated for any great length of time is conceded at once by every intelligent observer of road conditions, and many suggestions have been put forward as to how an improvement might be brought about. Road improvement is the great panacea of the road associations. It is claimed that development in the design of roads has failed to keep pace with the very rapid improvements in the vehicles which use them. Road surfaces should be light in colour to throw out in strong relief in the beams of the headlamps dark coloured objects, such as cyclists and pedestrians, and should have a high coefficient of friction even under the worst conditions of rain and snow. Super-elevation should be adopted at curves and unnecessary steepness of camber should be eliminated. Sharp, deceptive bends and blind or otherwise dangerous crossroads should be re-designed, and, where necessary, highly visible warning signs should be erected. In cities and urban areas it is suggested that pedestrian "traffic" might be regulated, and that improved forms of signal lamps will bring about improvements. Here, indeed, is scope for the engineer to make the roads as simple to travel upon as the machine he has devised is easy to drive and control. Supported by the road associations are various bodies, including the Government, that advocate education in road sense as a cure for accidents. The "Highway Code" is given to every applicant for a licence, and the mobile police constable is provided to admonish the delinquent and issue a summons against the reckless. Training in "road sense" becomes part of the syllabus of the school, and such bodies as the National "Safety First" Association carry on a valuable scheme of propaganda. Organised pedestrianism protests against excessive speeds, and points out effectively the difficulties and dangers of crossing roads in urban areas, and the peril involved by the lack of footpaths by the sides of main roads in the country. Lastly, the motorist points blandly at his neighbour as the miscreant who is the cause of all these accidents. Take steps, he suggests, to prohibit him from using the road, and all will be well.

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[*] The Engineer, May 26th, 1933.

Unfortunately, except for the last of these remedies, none can have any immediate effect. The engineer can do much to improve the safety of the road, but his work will take years to complete. Education can only have any pronounced effect upon the next generation. As to the elimination of the reckless driver, the practical difficulties involved make any attempt to do so hazardous in its result, although the number of persons involved, it is to be hoped, is small. Nor is any present legislative action likely to bring about any immediate improvement, since it could only be founded upon insufficient evidence. How much is really known about accidents? The statistics collected by the police show their number and the type of vehicle to which each was attributed. But such figures give a quite incorrect impression unless allowance is made for mileage. No mention is made of the cause of the accident nor the place where it occurred. Were statistics collected of all the relevant details they might yield valuable information. In urban areas where do accidents most frequently occur? In the side roads, in congested streets, or in those more open thoroughfares where speeds are greater? Is the "accident rate" of roundabouts higher than that of crossroads? At what hour of the day do most accidents occur? What are the effects of differing climatic conditions on the figures? Are the majority of serious accidents attributable to a small minority of drivers? How many are caused by mechanical failures of some part of the vehicle? What percentage could have been avoided if more efficient brakes had been fitted? The correlation and tabulation of all the available statistics collected by road associations, borough councils, insurance companies, and the police is surely necessary before a true picture of the state of affairs may be painted. Statistics, however, are of little value until they have been collected for a number of years, whereas the cry is for immediate action. Such action would, we believe, be unwise. Let us have no "panic" legislation. Time has not yet been given for the provisions of the Road Act to take full effect, much less for those effects to be measurable. To reinstate the 20 m.p.h. speed limit, as has been suggested in some quarters, would be not merely a retrograde step, but, when cars are built to have a touring speed of 40 m.p.h., an illogical absurdity. Besides, in 1929, before the speed limit was abolished, there were more fatalities on the roads than in 1932!

Literature.

British Industries and their Organisation. By G. C. Allen, Ph.D., M.Com. London: Longmans, Green and Co. 1933. Price 10s. 6d.

Most books on economics make dull reading, and it is pleasant to welcome an exception. Even when the aspect selected is historical many authors fail to escape from the dreariness of the science. Not so Mr. Allen. He pursues an easy course through the Staple Trades, Coal, Iron and Steel, Engineering, Shipbuilding and Marine Engineering, the Motor Trade, and Textiles, and brings us in the end to a review of British industry since the war without once inclining the reader to say "Here, indeed, is a book for the shelves, where it may consort with others in the collection of dry dust; not one for the table where all and sundry may pick it up and find pleasant matters."

It is with chapters on our own subjects that we must concern ourselves—Iron and Steel, Engineering, Shipbuilding, and the Motor Trade. Sometimes, when one reads about the decline of Great Britain's share in the iron and steel trades of the world, he is led to believe that it is all the fault of the industry, something to be ashamed of, something that need not have happened had our ironmasters been more wide-awake. It is worth quoting Mr. Allen to correct this false impression. "This historical survey," he writes, "throws light on the essential instability of this industry. It shows that a position of apparently unchangeable supremacy may be undermined in a short space of time by technical changes which destroy the relative advantages of some producing areas and confer leadership on others. The discoveries of Darby and Cort transferred predominance in their industry from countries with large timber resources to England with her abundant coal supplies. The hot-blast, within a few years of its introduction, created a great Scottish iron trade. The inventions of Bessemer and Siemens destroyed the importance of South Staffordshire as a producing centre and brought about the migration of the industry to coastal areas. The Thomas process enabled the vast ore supplies of Lorraine, previously of little account, to be employed for steel-making, and so made Germany the chief European producer. When new methods of production are introduced an old-established producing area or country is necessarily at a disadvantage. The previous basis of its trade is destroyed, and it cannot expect to possess the same relative advantages for the new technique as for the old. Its plant is rendered obsolete and its *personnel*, bred to the old methods, has difficulty in adjusting itself to the new." Mr. Allen finds that the decline of the iron and steel industry lies in the fall in demand for products in which her competitive position was strongest, and he thinks it possible that its future lies with "specialities rather than with bulk products." There are many who hold that view, yet it may be that the whirligig of time will bring back the industry to this island where coal and ore lie cheek by jowl. Have we not already the signs at Corby?

We wish we could quote at length from this chapter, which shows a surprising knowledge of an industry in which the author is not engaged, and which surveys the position from the standpoint of sound common sense. Unlike so many others, Mr. Allen does not charge iron and steel masters with backwardness and idleness, but shows real sympathy with their difficulties and problems. After referring to the enormous world capacity of iron and steel plants since the war, he concludes with these words: "The future importance of great combinations in the iron and steel trade will depend on the extent to which this country remains a producer of the bulk products. If, as is not improbable, she devotes an ever-increasing proportion of her iron and steel capacity to the manufacture of specialities, then the small firm, like the small plant, may retain its importance." An interesting consideration which all those who think nothing can be good that is not great may ponder.

The short chapter on "Engineering" is not so good. It exhibits rather too much reliance on derived information and seems to lack the personal touch—as if the author had not endeavoured to draw his own conclusions from his premises. We pass over it; it only occupies eleven pages.

It is followed by a chapter on shipbuilding, which, apart from the fact that it shows some evidence of having been written a good many months ago, affords an interesting and useful survey of the development and position of that industry. The author contrasts the pre-eminence which Great Britain attained in steam shipbuilding with her primary backwardness in the introduction of the oil-engined ship. With regard to the former he writes: "She was a country with a diversified industrial life, and so could produce the multitude of components and materials required. She had cheap coal and a great share of the world's carrying trade, which expanded enormously after 1850. Free Trade gave her shipbuilders access to materials at low prices. Finally, the coming of the steamship coincided with a period of British supremacy in metallurgy and engineering, and the technique of these industries came to the aid of a shipbuilding industry of long standing and great experience." With regard to the marine oil engine he remarks that "It was not to be expected that the United Kingdom should achieve a position of equal superiority in the construction of these new types as in the old; for her great resources of steam coal rendered a change to ships using other fuels less urgent for her owners than for those of other countries." That is the philosophical attitude; it is better than recriminations. It takes into account forces which so many critics overlook or under-rate. It takes time to arrest the momentum of an old-established industry. It cannot be done in a day, and the greater and more successful the industry has been, the longer is the process. That this country has progressed so far with the internal combustion engine in a couple of decades is all to her credit, and yet it is natural that the old forces which made British steam marine engineering supreme should still be active. After all, coal is the proper fuel of this country, and its reinstatement—in some form—would bring immediate benefits to Great Britain.

Mr. Allen appears to be not quite happy about recent movements in the shipbuilding industry. Of the Rebate Scheme he says: "Unfortunately, it is impossible to determine how far the operation of this scheme has maintained the cost of construction above the level which might otherwise have been reached. But it is significant that this great exporting industry now has to purchase the bulk of its materials from trades dominated by combinations and price-fixing associations"; and on another page he writes: "Yet as the yards still in existence are capable of producing 2½ million tons, while the maximum annual output of merchant vessels since 1921 has amounted to only 1,520,000 tons, it seems that the National Shipbuilders Security is still far from realising its aims." Yet in the last words of the chapter he admits that "the structure of one of the most individualistic of the British trades has at length been modified."

We skip a couple of chapters in order to conserve a little space for Chapter X., in which "British Industry Since the War" is reviewed. Here, as in some earlier pages, we observe omissions which are difficult to explain save on the assumption that the text was written many months ago. The most remarkable recent event in the industries of the country was the re-establishment of import duties, yet home tariffs are not discussed in any part of the book and are not mentioned even in this chapter. Since we can hardly assume that the author regards protection as an influence without moment in the development of industries, we suggest that the volume should bear the date 1930 or 1931 rather than 1933.

After the presentation of certain data and statistics, Mr. Allen asks two questions: "First, how is the change in the relative importance of the different industries—a world-wide phenomenon—to be explained; and secondly, why did Great Britain, of all the industrial nations, suffer the most severe losses in the older trades while failing to secure a compensating share of the growing industries?" It would take more space than we can spare to follow his argument, and we can do no more than mention his conclusion that the failure of Great Britain to maintain her place in international trade was due in large measure "to the displacement, as a result of changes in demand, of trades and qualities of goods in which she had specialised, and to the necessity for exceptionally great readjustments imposed on her industrial system by the circumstances of the post-war world." The chapter ends with the following passage, with which we must leave a book in the reading of which we have found much pleasure: "In any case, it is now generally recognised that Great Britain cannot expect her older staple industries to regain their previous importance in her economic life. The solution of her problems must ultimately come from a redistribution of labour among other trades. But it is by no means easy to discern what those trades are to be. Nor is it possible to state with confidence that in the future the advantages of Great Britain as an industrial centre will be sufficient to enable her to maintain a dense population at the standard of life to which she has been accustomed."

BOOKS RECEIVED.

Physical Mechanics. By R. B. Lindsay, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 21s. net.

Minerals Year Book, 1932–33. Washington: Superintendent of Documents, United States Government Printing Office. Price 1·25 dollars net.

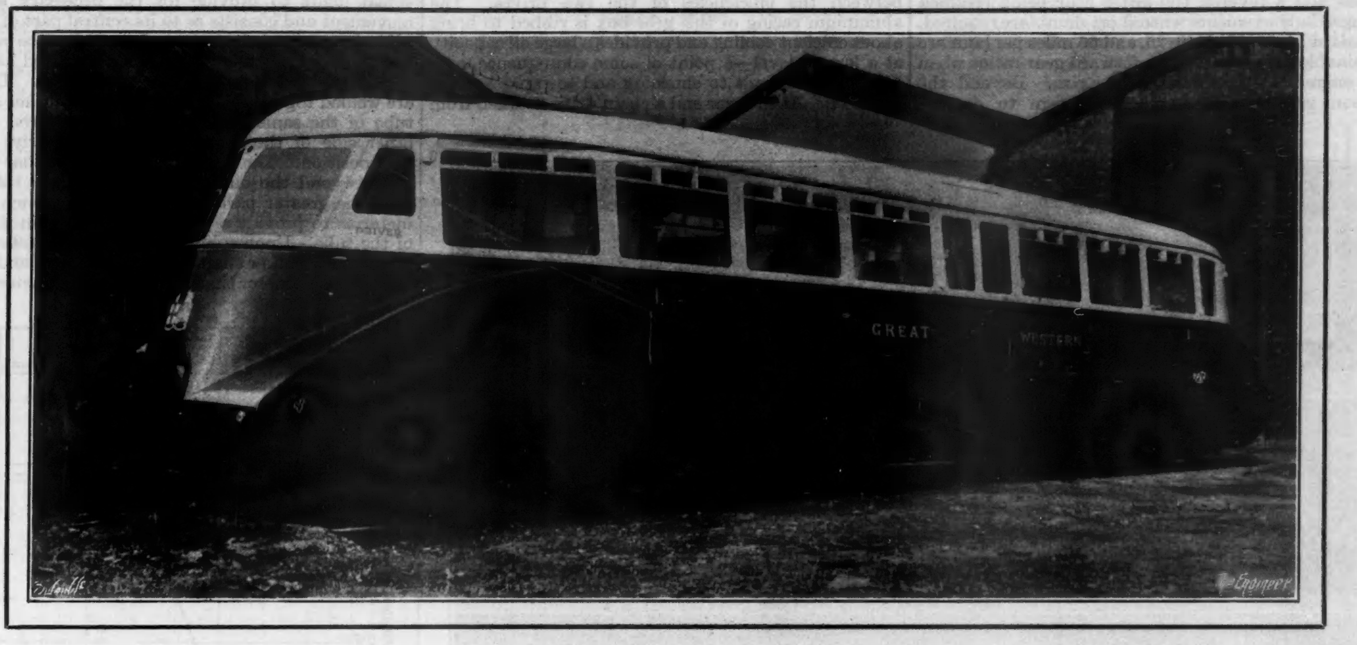
Marine Aircraft Design. By W. Munro, A.M.I. Ae. E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 20s. net.

Mechanics of Applied Heat. By S. H. Moorfield, M.Sc., and H. H. Winstanley, B.Sc. London: Ed. Arnold and Co., 41, Maddox-street, W.1. Price 5s. net.

British Bridges: An Illustrated Technical and Historical Record. Published by the Organising Committee of the Public Works, Roads, and Transport Congress, 84, Eccleston-square, S.W.1. Price 10s. 6d. net.

130 H.P. RAILCAR FOR GREAT WESTERN RAILWAY

HARDY MOTORS, LTD., SOUTHALL, MIDDLESEX, ENGINEERS



130 H.P. Oil Engine-Driven Railcar.

At the end of last July we were able to give a short illustrated description of the chassis of an oil engine-driven railcar manufactured by Hardy Motors, Ltd., of Southall, and fitted with a 130 H.P. A.E.C. oil engine. At that date the vehicle was still more or less in the experimental stage, and some of the smaller details of its design were not definitely settled. Nor were the makers ready to publish details of the body which was to be fitted to it. The experimental running of the chassis has now been satisfactorily completed, and as may be inferred from the engraving at the head of this page, the body has been fitted. The complete vehicle, which will be shown at the Commercial Motor Transport Exhibition opening at Olympia next Thursday, has been purchased by the Great Western Railway Company, and will enter service, probably between Slough and Reading, at the close of the Exhibition.

The coach, as will be observed from the engraving above and the drawing, Fig. 1, is of a stream-lined form. It was made and fitted to the chassis by Park Royal Coachworks, Ltd., of Abbey-road, Park Royal, N.W.10. The reduction of windage resistance and judicious saving of weight in the design of the chassis has made it possible for the 130 H.P. engine to give the vehicle a satisfactory performance. Carried on two four-wheeled bogies, the car is 62ft. long by 9ft. wide overall, and weighs less than 20 tons. The power-weight ratio is therefore higher than it is on most railway trains or vehicles. Besides a luggage compartment at one end, the coach has accommodation for sixty-nine passengers, but we understand that as many as eighty-eight could be carried if the luggage compartment was not present and the seating rearranged. The important influence of the smoothness of the exterior of the body on the windage resistance has been fully realised, and there are practically no external projections whatever. Even the steps to the driver's cab from rail level have been arranged to be covered by flaps when the door above them is closed, and hinges which must project are of stream-line form. The coach is painted in G.W.R. colours. It was designed to follow out the results of wind tunnel tests on a number of models, some of which are illustrated in Fig. 2. A graph—Fig. 4—the curves upon which are lettered to correspond with the model photographs in Fig. 2, shows the wind resistance in pounds of the models plotted against speed of motion. The curves have been extended beyond the results of the actual wind tunnel tests themselves, as shown by the dotted lines, in order to judge of the performance of the vehicles at higher speeds. Curve F, which shows a very high resistance, applies to a coach with flat ends of conventional form, except for the shrouding of the wheels. It was taken in order that some basis for the comparison of the stream-lined vehicles might exist. The best results were achieved by the model A, but, as we think our readers will agree, a vehicle constructed to have the shape of this model would be frankly ugly. A design which would give comparable results and at the same time have a pleasing form was therefore sought, and models B and C were the result. At first glance, these two might be taken to be identical, and, in fact, the only difference occurs in the shape of the roof, which in B is curved upwards at the centre 6in. relatively to C. The surprisingly large influence of this small change of shape may be traced upon the graph. As might be inferred from the engraving at the head of this article, it was decided to construct the body in accordance with the shape of model B. The other curves on the graph refer to models of other forms examined by the makers, but since they had no influence on the final design adopted, they need no further reference here.

The Chassis.

The design of the chassis of this railcar is unusual in that the engine is placed within the body and to one side of the frame near the middle of its length. Regarding, for purposes of description, the driving bogie end as the rear end of the double-ended coach, the engine is situated on the left-hand side of the frame a little forward of the central position. The arrangement will be made clear by a reference to the drawings reproduced in a Supplement to this issue, and by the photograph reproduced in Fig. 3. Both axles of the rear bogie are driven and the whole transmission system lies outside the main frame on the left-hand side of the vehicle. The mechanism is, however, hidden from view in the completed coach by the shrouding which extends to within a few inches of the rails. As far as possible, consistent with the best modern practice in railway carriage construction, weight has been saved in the main frame and bogies, so that the total weight of the chassis is only 13 tons 10 cwt. The general design may be followed from the drawings reproduced in the Supplement. Before a choice was made consideration was given to the advantages of several different types of bogies and a design was finally decided upon that could readily be adapted to suit both the braking and driving systems it was intended to employ. As will be seen from the drawings, each bogie is of the swing link bolster type, with laminated springs over the axle-boxes and an auxiliary rubber suspension block; and nests of coil springs between the bolster and spring plank. The main frame allows the engine and the various units of the transmission system to be conveniently carried by outrigger members cantilevered from it. An additional advantage of the construction is that convenient steps from rail level into the body of the car at the central vestibule can be built in without the necessity for any projection that might increase the air resistance of the vehicle. A "trap door" in the floor may be raised and steps have been built in below the floor and clear of the frame to rail level. A panel on the body opposite the steps is hinged and so connected with the "trap door" that it opens outwards as the flap is raised. The main members of the frame are 10in. by 3½in. channels trussed with 4in. by 4in. by ½in. angles.

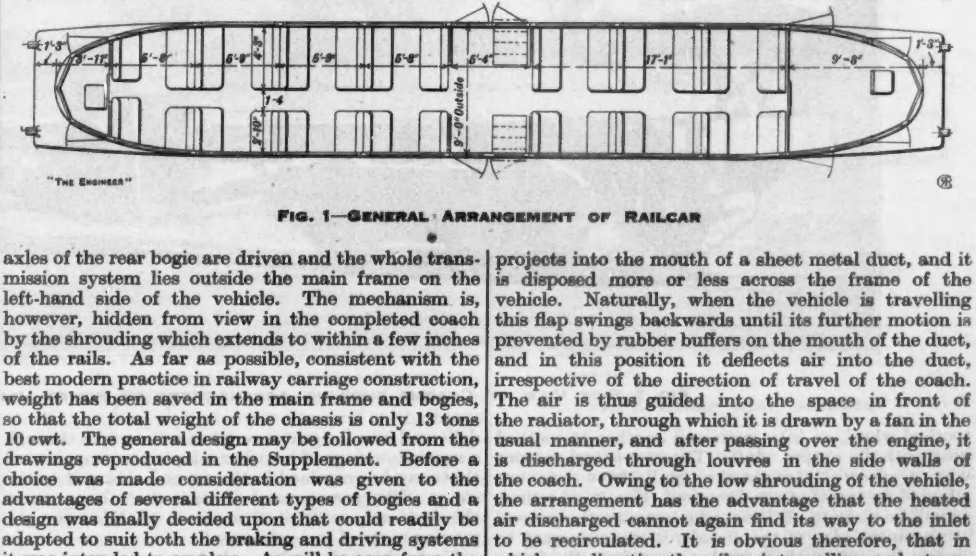


Fig. 1—General Arrangement of Railcar

Engine and Transmission.

As a result of careful stream-lining of the body and judicious saving of weight in the chassis, the 130 H.P. A.E.C. oil engine, similar to that fitted in many commercial road vehicles, provides ample power. The radiator for the engine is mounted conventionally in front of it. Since, however, the whole engine unit is enclosed within the bodywork of the coach, special measures had to be taken to cause a flow of air through the radiator. Beneath the car there is a swinging sheet metal flap hung on a vertical axis. Its free end projects into the mouth of a sheet metal duct, and it is disposed more or less across the frame of the vehicle. Naturally, when the vehicle is travelling this flap swings backwards until its further motion is prevented by rubber buffers on the mouth of the duct, and in this position it deflects air into the duct, irrespective of the direction of travel of the coach. The air is thus guided into the space in front of the radiator, through which it is drawn by a fan in the usual manner, and after passing over the engine, it is discharged through louvres in the side walls of the coach. Owing to the low shrouding of the vehicle, the arrangement has the advantage that the heated air discharged cannot again find its way to the inlet to be recirculated. It is obvious therefore, that in whichever direction the railcar is travelling, a plenteous supply of cool air will be drawn through the radiator.

Immediately behind the engine there is a fluid flywheel, which takes the place of a clutch. Thence a shaft with two universal joints takes the drive to the pre-selective gear-box of the Wilson type. It is at this point that descent from the interior of the coach to rail level is made, and the shaft is so placed that it does not interfere with the construction of the steps mentioned above. The gear-box gives four forward speeds and a reverse, the latter gear being retained owing to its convenience when short shunts are required. Speeds of 14·45, 25·4, 40·25, and 60 miles per hour are obtainable by the use of the forward gear ratios when the engine is turning at 2260 r.p.m. Beyond the Wilson gear-box the next mechanism to deserve notice is the reverse gear-box, a section through which is reproduced in the Supplement. In whatever direction the vehicle is travelling there is no conventional direct drive, as a study of the engraving will demonstrate at once. The output shaft is situated below and further from the main frame of the vehicle than the input shaft and connected with it by constant mesh gears. A dog clutch engages the input shaft, upon which it rides, through two 43-toothed intermeshing gears, or alternatively through a 35-toothed wheel, an idler gear, and another 35-toothed gear, with the output shaft. There were two reasons why a direct "straight-through" drive was not adopted for travel in one direction. Firstly, of course, as will be clear to all those who examine the general arrangement plan of the chassis, it was necessary to situate the output shaft further away from the frame than the input shaft in order to take the drive to the axles in the manner shown. But of far greater influence was the fact that, given a "straight-through" drive in one direction, no less a number of gear wheels than five is necessary to obtain reverse. An arrangement by which two gear wheels were engaged for the drive in one direction and three for the drive in the other involved no greater number of gear wheels and made no such great distinction between the efficiencies of the two drives. The aluminium casing of this gear-box is ribbed to bring about efficient cooling and provides a large oil capacity at a low oil level—a point of some consequence, as a high oil level leads to churning and to rapid heating of the oil. At the rear end a chain drive is taken from the output shaft to a rolling drum exhauster mounted on the top of the gear-box. This exhauster maintains the vacuum in the reservoirs of the brake system and is additional to another exhauster driven directly by the engine. It is provided to maintain the vacuum when, for instance, the vehicle is coasting down a long hill with the gears of the "Wilson" box in neutral and the engine idling, under which conditions the engine-driven exhauster is more or less out of action owing to its low speed. The exhausted air is delivered into the gear-box, whence it escapes through a specially designed breather adapted to trap any oil that may be entrained in the air and return it to the sump. The arrangement is such that the gears in the box act as "oil throwers" to lubricate the moving parts of the exhauster.

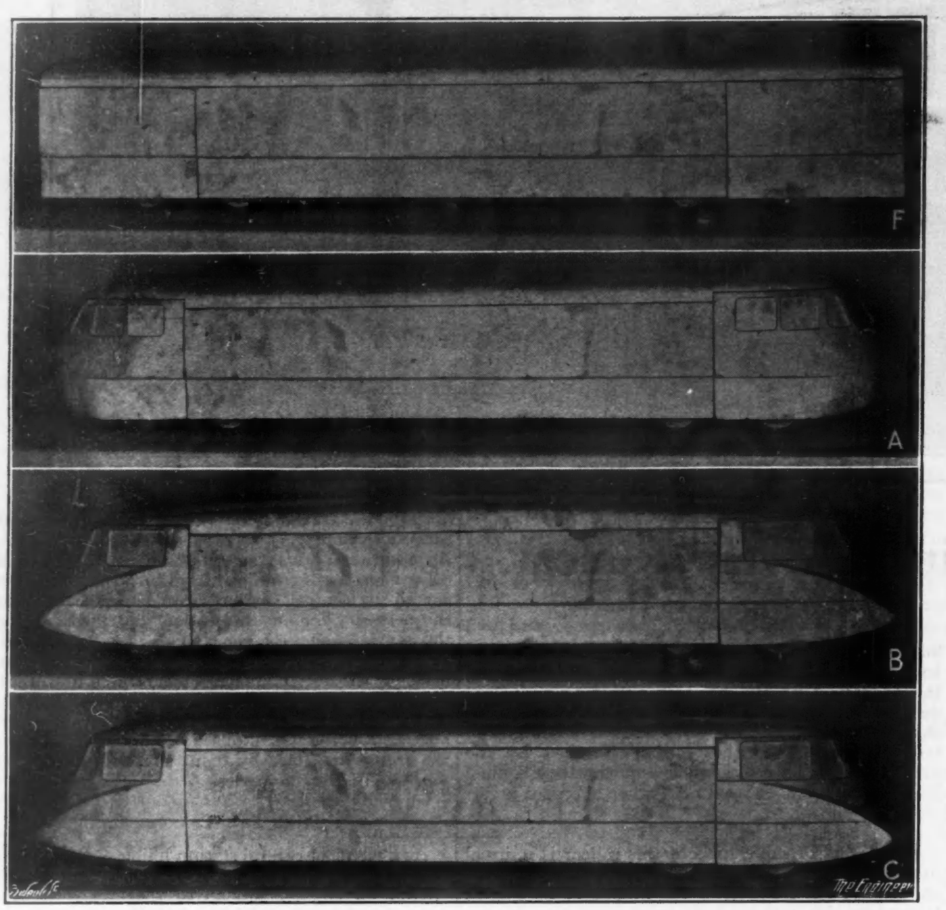


Fig. 2—Models for Use in Wind Tunnel Tests

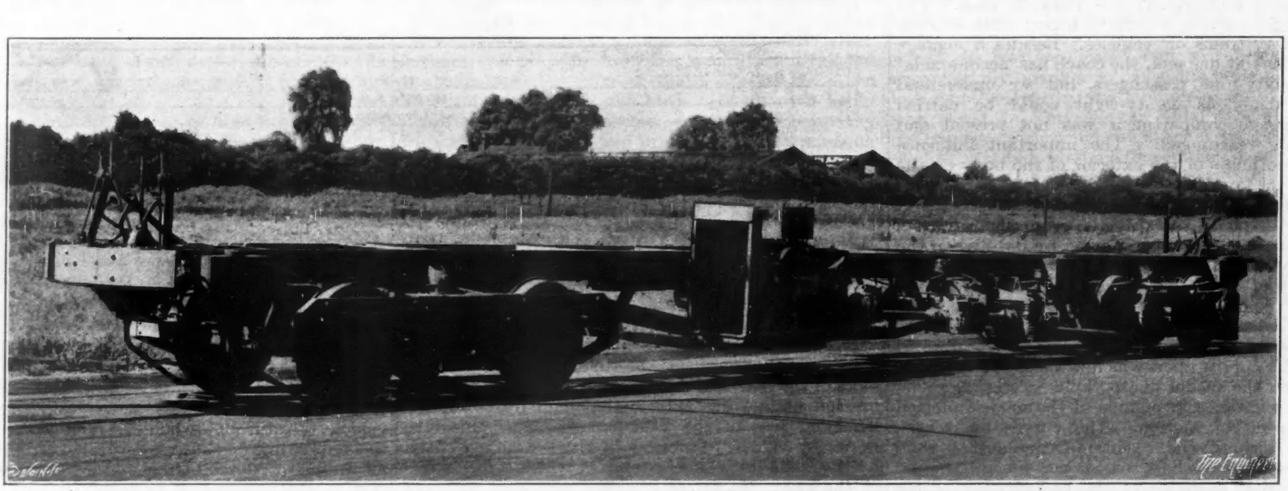


Fig. 3—Side View of Chassis showing Arrangement of Power Unit and Transmission

Up to this point it has only been necessary to provide universal joints in the connecting shafts between the units of the transmission system to allow for differences of angularity. In the connection between the reverse gear-box and the driving axles, however, a further degree of flexibility is necessary in order to allow for rotation of the bogie round its centre pivot. The design of the telescopic shaft forming this link in the system may be seen in the drawing Fig. 5. It is carried between two universal joints to provide for the necessary angular movement and consists as to its central part of a tube 3½in. in external diameter. Into this tube at each end there is fitted the "butt" of a solid rod having a shoulder of the same diameter as the tube. The two are welded together at the shoulder. Another shorter tube of the same diameter fits over the rod on the other side of the shoulder and is similarly welded into position. The rod is of such length that it projects beyond the outer end of the second tube and over the greater part of its length is of such a diameter as to provide a wide clearance within the bore of the tube. Upon splines cut on the projecting part of the rod a hollow shaft is adapted to slide, and, being of smaller diameter than the internal diameter of the tube, its end can project into the clearance space between the rod and the tube. The outer ends of these two hollow shafts connect with the universal joints at each end of the telescopic shaft assembly. As will be seen from the drawing, covers screwed on to the ends of the tubes and nuts screwed on to the ends of the shafts prevent the complete withdrawal of the shafts from within the tubes, but dismantling of the assembly is easily performed by the removal of the caps, which are held in position by locknuts and contain a sealing ring to prevent leakage of the lubricant. A motion of 4½in. is provided at each end of the assembly and lubrication is obtained by filling the clearance spaces with grease.

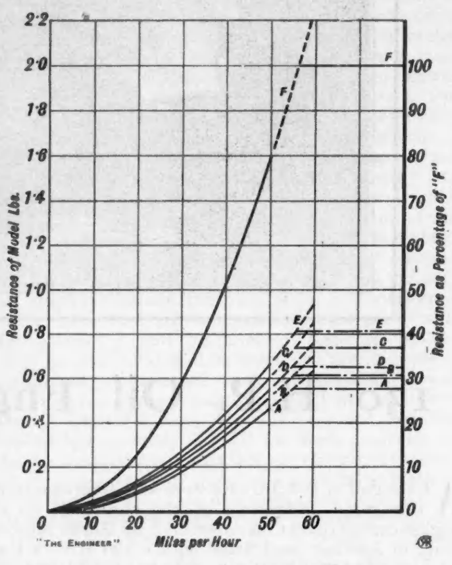


Fig. 4—Results of Tests of Models in Wind Tunnel

The next mechanism to be described is particularly interesting, and the true merits of the design cannot be appreciated without considerable study of the drawing reproduced in the Supplement. Both axles of the rear bogie are driven—see also Fig. 6—through worm and wheel mechanisms, and as any difference in the diameters of the wheels would set up undesirable stresses in the shaft between the two worms an inter-axle differential gear is housed in the casing of the leading axle-box. The drawing reproduced in the Supplement refers to this leading axle. In general, the design of the worm drive to the other axle is the same except for such differences as the omission of the differential brings about. The main feature of the design, which is covered by patents, is the manner in which the worm is carried in the axle-box casing.

From the flange which is attached to the universal joint of the telescopic shaft the drive is taken to the central member of the differential gear. One of the outer members of the differential passes on the drive to the second axle, while the other is solid with the worm driving the first axle. The neat manner in which the various parts are firmly supported is better discovered by examination of the drawing than it can be described here. The worm wheel is bolted and splined to a flange carried on the axle itself, and the manner in which its mesh with the worm is adjusted deserves mention. It will be observed that there are two end covers for the worm wheel assembly, the smaller bolting into the larger. A ball thrust and journal bearing is carried by the smaller of these two covers. Since the large roller bearings that transfer the load of the vehicle on to the axle are so designed as to have no locating properties, it is this ball bearing that locates the casing relatively to the axle. Thus by placing shims between the smaller cover and the face to which it bolts the position of the axle relative to the axle-box—or, in other words, the position of the worm wheel relative to the worm—may be altered. Another important feature of the whole design becomes apparent after a little study of the drawing. The whole of the worm and wheel mechanism may be dismantled for repair, replacement, or examination without even relieving the axle of the weight of the vehicle. Removal of the larger cover allows the worm wheel to be withdrawn, while the worm assembly is easily removed when the end covers of its casing have been taken away. Moreover, all these covers are situated accessibly at the side of and not beneath the vehicle.

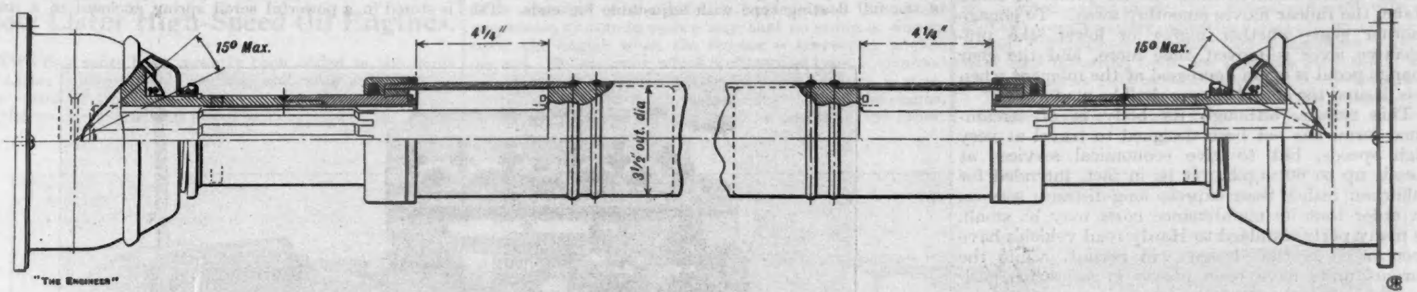


FIG. 5—THE TELESCOPIC SHAFT BETWEEN REVERSE GEAR-BOX AND FINAL DRIVE

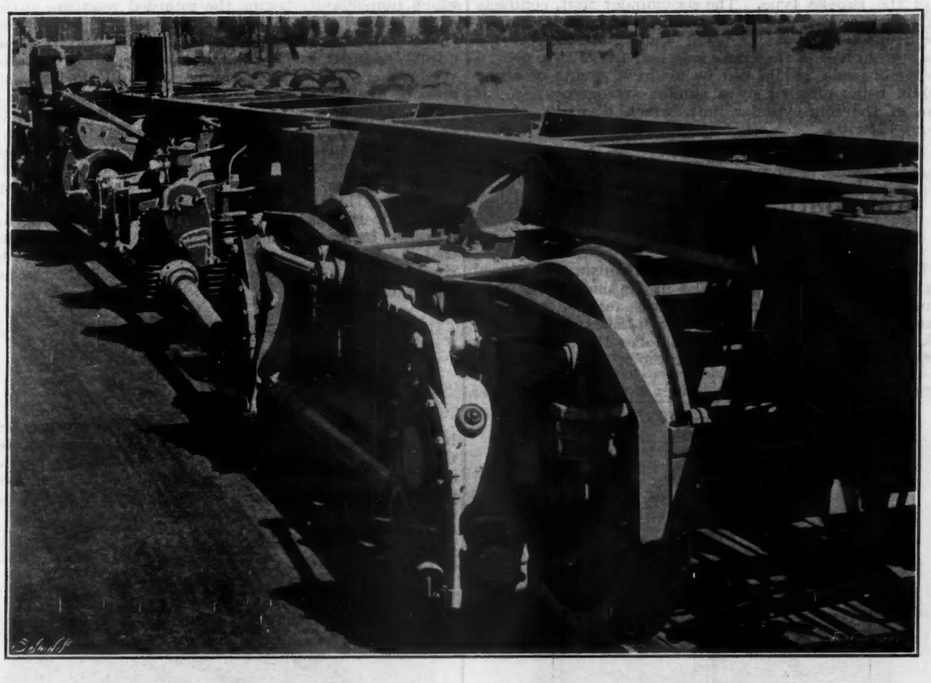


FIG. 6—THE DRIVING BOGIE

As we have already noted, the axle rotates in roller bearings within the axle-box. An arm projecting from the top of this box is attached by a ball-ended lever to the end of a torque rod. The springs, therefore, which are clamped to the axle-box sleeve take none of the torque. A small detail indicative of the care and thought which has been put into the design of the railcar is illustrated by the accompanying sketch, Fig. 7. Here the large circle indicates the wheel. The axle-box and its guides, together with the torque rod, are also shown diagrammatically. Supposing the vehicle to be travelling towards the right, the torque reaction will be anti-clockwise and the torque rod, attached above the axle, in tension. Thus the force in the torque rod tends to pull the axle-box against just that set of guides on which the pressure to drive the vehicle along is being exerted. Were the torque rod to be connected below the axle, as indicated by the dotted lines, its effect would be in opposition to the driving pressure, and the arrangement might well give rise to chatter at the driving face of the guides. The axle-box itself is also mounted in a sleeve so that the thrust on the guides may be truly normal. Otherwise one of the effects of torque reaction would be to give the box a tendency to cant in the guides and bear only on the corners.

BRAKE GEAR.

In the brake gear a departure has been made from conventional railway practice by the fitting of internal expanding brakes similar to those of a road vehicle. Between road and rail vehicles, however, there is the essential difference as far as brake gear is concerned that in the one case the wheel may be readily removed, while in the other it may not. The mechanism is so arranged on this railcar that access can be gained to the shoes, operating cams, and pivot pins without removing the drums or wheels. The whole assembly, a drawing of which is reproduced in Fig. 8, is mounted on the axle behind the wheel. The drums themselves, split to be removable for truing up or replacement, are bolted and registered into the wheels, while the rest of the gear is mounted on a carrier riding on roller bearings on the axle and prevented from rotating by a torque rod. A split collar clamped to the axle retains the carrier in the correct position and holds it up against the face of the wheel. It will be clear from this description that it is only necessary to slack back the retaining collar, detach one end of the torque rod and disconnect the brake rod in order that the whole carrier may be slid back along the axle and the various parts mounted upon it inspected.

Two vacuum cylinders are mounted on each bogie. Each is independently connected to the brake cam shaft lever of one axle, so that complete compensation of the brakes is ensured. A cross-shaft of compensating type coupled to the hand brake lever in the driver's compartment is also connected to the brake cam levers. Vacuum for the brakes—and also incidentally for the sanding gear—is maintained by two exhausters, both of which have already been mentioned. Three reservoirs are mounted beneath the chassis, and gauges in the driver's compartments show the vacua in these reservoirs and in the brake pipe.

Before passing on to describe the controls, it should be noted that a large-capacity electric accumulator battery is mounted on the frame just opposite to the engine, while the fuel tank is on the same side as the accumulator, but further back.

CONTROLS.

The controls under the charge of the driver are arranged in an identical manner at each end of the vehicle. They comprise an accelerator pedal, a preselective gear lever, a reverse gear lever, a ratchet hand brake, a finger-control lever for the vacuum brake, and another for the sanding gear. Lastly, there is a pedal for changing gear in the Wilson box, for it will be recalled that in this type of box the next gear to be engaged is pre-selected, but not actually engaged until a second control is operated. The hand brake lever at each end of the coach only applies the brake on the wheels of the bogie immediately beneath it. The two levers are thus not interconnected. In the case of the reverse gear lever and the preselective gear lever, however, interconnection is necessary. It is obtained by means of steel ribbons attached to the ends of double-ended levers mounted beneath the coach and rotated by the controls. The arrangement is such that whatever the direction of rotation one of the ribbons is in tension. Approximately half-way along the vehicle a double-ended lever is mounted between the two ribbons and to it is attached a rod making connection with the mechanism controlled. A similar arrangement has been adopted for interconnecting the gear change pedals at each end of the car with the Wilson gear-box. As, however, the "working" movement is always in the same direction and a spring can be arranged to give the return motion, only one steel ribbon is required, and it is always in tension.

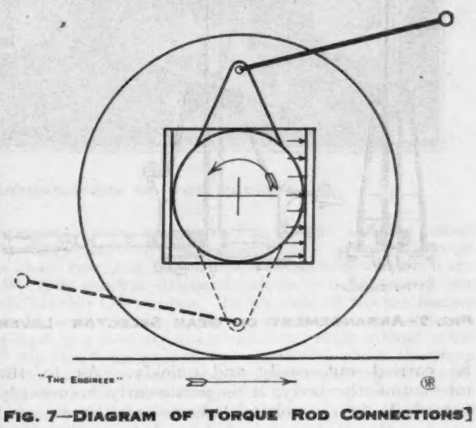


FIG. 7—DIAGRAM OF TORQUE ROD CONNECTIONS

As the gear-selecting lever works in a "gate" trouble might arise through the gate at one end of the vehicle interfering with the free motion of the lever at the other. To make any such state of affairs impossible, only one gear-selector lever is supplied. It is so arranged—see Fig. 9—that it may be lifted out of its socket and, when the direction of motion of the car is reversed, carried from one end of the coach to the other. It is the toe of this detachable lever that engages with the gate, so that when it is removed no interference is possible. There are only four slots in the gate corresponding to the four

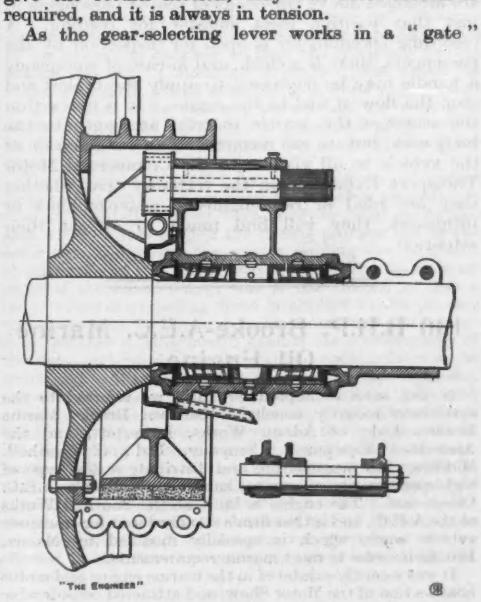


FIG. 8—BRAKE GEAR ASSEMBLY

forward ratios available. Reverse is obtained by lifting the lever slightly to clear the gate and drawing it back as far as it will go.

The coach is very simple to drive. An electric starter brings the engine into action. The reverse lever is next thrust in the direction in which it is desired to travel, and the pre-selective gear lever is brought through the gate to the " first " or " second " gear position. Then, on pressing down the gear change pedal and releasing the air brake or hand brake, the railcar moves smoothly away. To engage another gear—whether higher or lower—the pre-selective lever is moved once more, and the gear change pedal is again depressed at the moment when it is desired the actual change shall be made.

This railcar, although its body is of stream-lined form, has not been designed to travel at very high speeds, but to give economical services at speeds up to 60 m.p.h. It is, in fact, intended for suburban rather than express long-distance service. In order that its maintenance costs may be small, as many parts standard to Hardy road vehicles have been used as the design will permit, while the various units have been placed in accessible positions so that the replacement of worn parts may be carried out easily and quickly. As to the interior of the body, it is particularly luxuriously furnished in a colour scheme of brown and green; the seats are upholstered in leather, and the passengers sit back to back. At one end a door leads into the luggage compartment, but at the other glass panels are interposed between the driver and the interior of the coach. As long windows are arranged on each side, the coach has a visibility as good as that of an " inspection " car. Deep luggage racks are provided and lights mounted beneath them are arranged above the heads of seated passengers in just that position most suitable for reading. A recording speedometer is open for inspection by the passengers, there is a clock, and in case of emergency a handle may be depressed to apply the brakes and stop the flow of fuel to the engine. It is not within the scope of this article to refer at length to the bodywork, but we can recommend an examination of the vehicle to all visitors to the Commercial Motor Transport Exhibition in the certainty that whether they are road or rail engineers, coachbuilders or furnishers, they will find much to attract their attention.

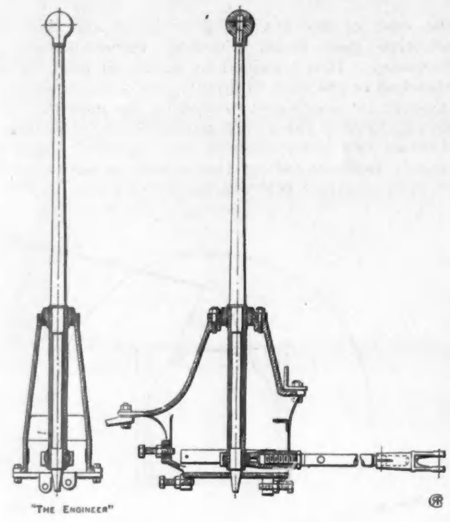


Fig. 9—Arrangement of Gear Selector Lever

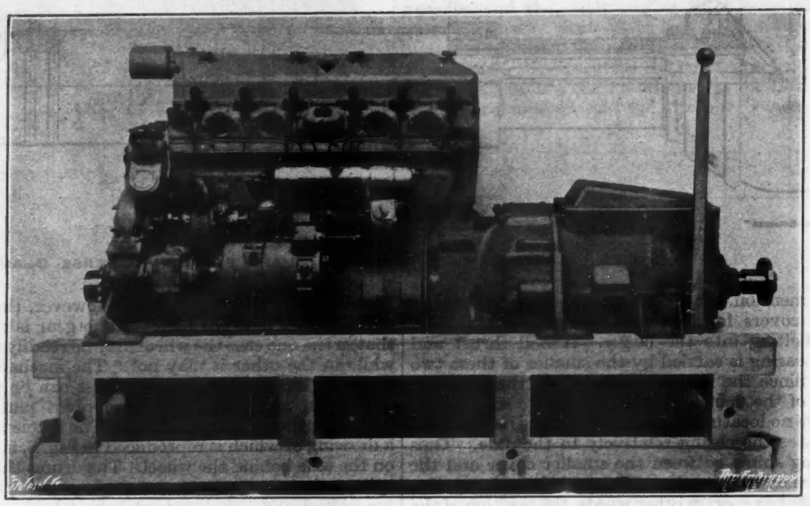
130 B.H.P. Brooke-A.E.C. Marine Oil Engine.

In our issue of September 15th, we referred to the agreement recently concluded between Brooke Marine Motors, Ltd., of Adrian Works, Lowestoft, and the Associated Equipment Company, Ltd., of Southall, Middlesex, to manufacture and distribute a new type of high-speed marine oil engine, known as the Brooke-A.E.C. Diesel unit. The engine is built at the Southall Works of the A.E.C., and is that firm's standard unit for transport vehicle work, which is specially modified by Messrs. Brooke in order to meet marine requirements.

It was recently exhibited in the marine engine and motor boat section of the Motor Show, and attracted considerable attention. Two models are included in the new range—a four-cylinder unit, with a bore of 108 mm. and a stroke of 146 mm., designed to develop 40 to 70 B.H.P., and a six-cylinder unit, with a bore of 115 mm. and a stroke of 142 mm., with a designed output of 70 to 130 B.H.P. at speeds from 1000 to 2000 r.p.m. We illustrate the larger engine herewith.

The fuel consumption at full load is about 0·40 pint per B.H.P.-hour at 1000 to 1200 r.p.m., and rises to about 0·44 pint at 2000 r.p.m. and 0·51 pint at 2500 r.p.m. Although the normal full speed is 2000 r.p.m., during trials a speed of 3000 r.p.m. has been reached on several occasions. The brake mean effective pressure developed varies from 112 lb. per square inch at 1000 r.p.m. to 108 lb. per square inch at 2000 r.p.m.

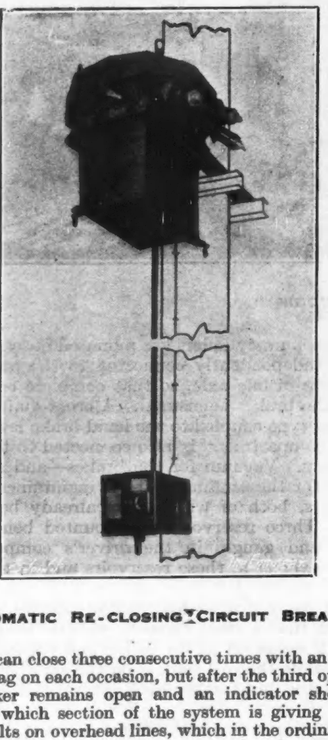
Special points in the design, which follows generally standard A.E.C.-Brooke practice, includes a cylinder casing of monobloc construction, cast in electron alloy, which is strongly ribbed to support the crank shaft. The lower casing is of cast iron with a large oil sump fitted with an oil baffle. The main bearings of the six-cylinder engine we are describing are 85 mm. diameter, with 75 mm. diameter crank pins, and a stiff crank shaft is employed with a drop forged steel connecting-rod. The bearing metal, which is lead bronze for the pressure parts and white metal for the caps, is cast into steel shells, while the small ends of the connecting-rods are of the full floating type with adjustable big ends. The pistons are made of Y metal, heat treated, and are specially long in order to avoid tipping. There are two cast iron cylinder heads, each covering three cylinders, which carry the valves, valve rockers, and the combustion chambers. A swirl chamber of the A.E.C.-Ricardo type is used with an oblique passage connecting it to the main combustion space. The fuel injection equipment is of the standard C.A.V.-Bosch pattern, which firm also supplies the 24-volt generator unit and starting motor. A gear-type circulating pump of special design is provided and the reverse gear is of the Brooke type. The six-cylinder unit, complete with reverse gear, electric starter, and exhaust manifold, weighs 2300 lb., but by using aluminium castings for the bottom half of the crank case and the reverse gear, a saving of some 200 lb. can be made, a saving of about 180 lb. being effected by a similar arrangement in the case of the four-cylinder unit, which normally weighs about 1750 lb.



130 B.H.P. Marine Oil Engine

Automatic Re-closing Circuit Breakers.

The reclosing circuit breaker mechanism, introduced by Johnson and Phillips for use in conjunction with the firm's " E.K.C." circuit breakers, was referred to in the article on the Ringmer and District Electricity Undertaking described in our issue of October 13th, but further details may prove of interest. On the occurrence of minor faults, it can close three consecutive times with an increasing time lag on each occasion, but after the third operation the breaker remains open and an indicator shows the linesman which section of the system is giving trouble. Minor faults on overhead lines, which in the ordinary way are liable to give rise to long interruptions in the supply, are therefore dealt with automatically and the risk of consumers becoming dissatisfied as the result by having to wait lengthy periods for the renewal of the supply is minimised.



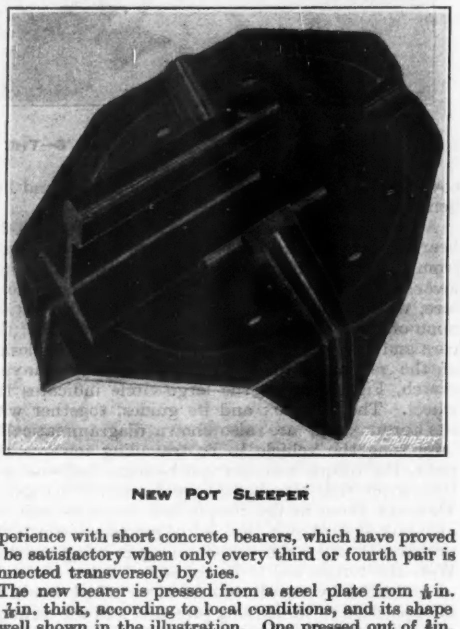
Automatic Re-closing Circuit Breaker

The mechanism is contained in a short steel box, which takes the place of the usual operating handle, and is situated near the foot of the pole, as shown in the illustration. It is wound by hand and can be set for one, two, or three reclosing operations. If an inspector finds on visiting the pole that the breaker has on some occasion tripped once or twice, but is still in circuit, he can rewind the mechanism for the full number of operations without interrupting the circuit. As the mechanism is operated purely mechanically, there is no motor or other electrical device. The energy necessary for operating the breaker is stored in a powerful scroll spring enclosed in a dust-tight case, through which the shaft to which the spring is anchored projects for the reception of the removable winding handle, which is simply turned through three revolutions. A crank at the rear of the case transmits the motion to the breaker by means of a connecting-rod, the resetting stroke being retarded by an adjustable dash-pot in order to give the requisite time delay between tripping and reclosing. The usual time lag recommended is about 30 seconds. When the breaker trips electrically, the action of the switch releases the automatic reclosing mechanism, which immediately begins the retarded resetting stroke, which is followed by the rapid closing stroke. If the short-circuit remains, the breaker trips again and is subsequently reclosed, but if after the third reclosing operation the breaker still opens it is automatically locked out, and must be reset by hand after the fault has been removed.

By means of a lever on the underside of the case, the switch can be opened at any time, and it is impossible to break the circuit slowly. By moving the lever to the left, the breaker is closed and means are provided for locking the lever in the " on " and " off " positions. An indicator in front of the case shows at a glance the number of reclosing operations for which the mechanism is set, and when the breaker is " off." Care has been taken to ensure that the apparatus cannot be interfered with by unauthorised people, and overwinding is prevented by the provision of a stop.

A New Pot Sleeper.

A new form of pot sleeper or rail bearer, which has been brought out by R. A. Skelton and Co., of Moorgate Station Chambers, London, E.C.2, is shown in the accompanying illustration. It is intended for light railways, and follows a steel sleeper of more orthodox design which was produced by the same firm last year. It is the result of experience with short concrete bearers, which have proved to be satisfactory when only every third or fourth pair is connected transversely by ties.

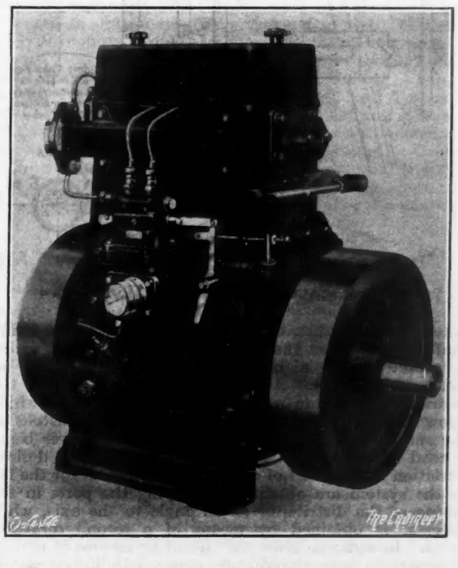


New Pot Sleeper

The new bearer is pressed from a steel plate from $\frac{1}{16}$in. to $\frac{7}{16}$in. thick, according to local conditions, and its shape is well shown in the illustration. One pressed out of $\frac{3}{8}$in. plate, measuring 2ft. by 2ft., weighs about 61 lb. The pots are protected from rusting by being dipped in bitumastic compound. They can be easily packed or tamped from any of the corners, and can be laid at wider centres than ordinary steel sleepers. They also have a longer bearing for the rail. The rail can be fixed either by long tapered keys, as shown, or the bearer can be arranged for the accommodation of a cast iron chair. The four holes provide for the bars, arranged either transversely or diagonally.

New Lister High-Speed Oil Engines.

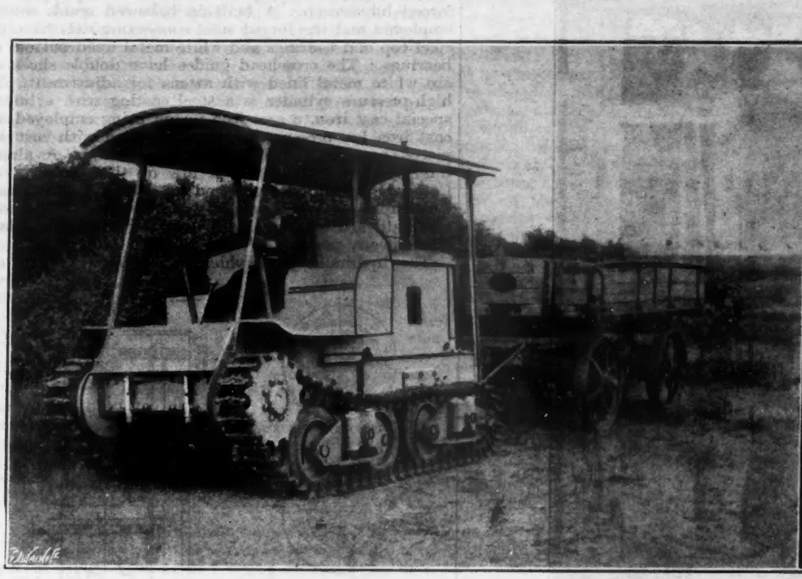
Two new units have recently been added to the range of Lister high-speed oil engines, and were exhibited on the stand of the Ruston-Lister Marine Company, Ltd., in the marine engine and motor boat section of the recent Motor Show. The larger of the two units—a twin-cylinder engine with a bore of 4½in. and a stroke of 4¾in., designed to develop 10 to 16 B.H.P. at speeds from 800 to 1200 r.p.m.—is illustrated herewith. The smaller engine is a single-cylinder unit of half the power, and it has a rating of 7 B.H.P. at 1000 r.p.m. The crank case and base plate of the new engine are cast iron, and the casing embodies the water jacket, into which the liner, which is of special iron centrifugally cast and nitrogen-hardened, is fitted. The piston is of high quality aluminium alloy, and carries four pressure rings. A combustion chamber of the Lister patented type is employed with a hand lever for compression adjustment, which lowers the compression for barring round and raises it for starting and light running. The fuel pump unit is neatly arranged on a bracket on the crank case chamber, and is directly controlled by the centrifugal governor. A pressure system of lubrication is fitted which supplies all parts of the engine, excluding the small end bearing and the cam shaft, which are splash lubricated. The full load fuel consumption is about 0·6 pint per B.H.P.-hour, and it is claimed that a wide range of fuel oils can be used. The engine has been designed either for marine or industrial services.



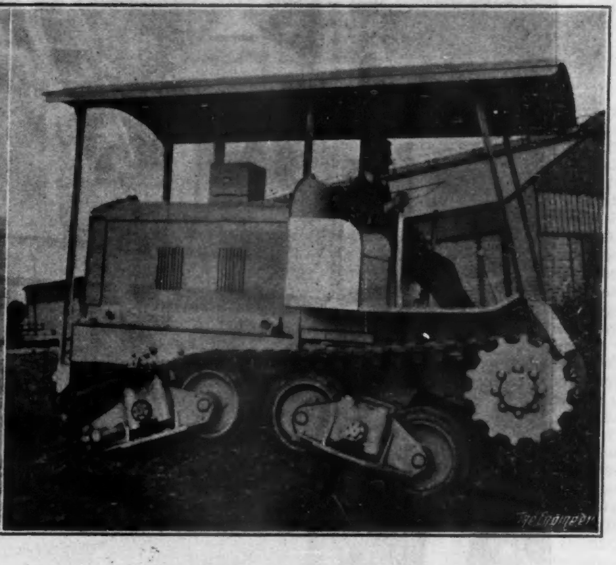
TWIN CYLINDER 10-16 B.H.P. OIL ENGINE

Oil Engine-Driven Caterpillar Tractor.

A new tractor with caterpillar tracks, just developed by Richard Garrett Engineering Works, Ltd., of Leiston, is illustrated by the accompanying engravings. Although intended primarily for use in the Colonies, it is believed that it will find many applications of an agricultural character in this country. One of its features is the provision of two gear-boxes, one of which—the main box—gives three forward speeds and a reverse, while the other provides two ratios, high and low. For ordinary light work "auxiliary" high is permanently engaged and the machine is operated entirely by means of the main box at speeds up to 12 m.p.h. But when heavy haulage is required, as in logging, "auxiliary" low is engaged and the main box then gives speeds between 1 and 6 m.p.h. A petrol, a paraffin, or an oil engine may be installed. It is mounted on a sub-frame carried on a three-point suspension system in such a way that no strain is thrown upon the engine when the tractor is traversing uneven ground. The radiator, which is of tropical type, is mounted at the rear and the fan which draws air through it is enclosed in a compartment separate from that of the engine, so that the hot air and dust has no access to the latter. Steering is carried out by the use of two independent clutches operated by two hand levers. When a lever is first moved the clutch is disengaged, and further movement applies an external contracting brake on the clutch drum. The tractor may therefore be turned very quickly. By pulling both levers hard back the brakes are applied. Four independent articulated bogies allow the tracks to conform to the contour of the ground surface. These bogies are mounted on two dead cross axles, secured to the main frame. Special round section springs fitted in plunger brackets allow the bogies to rise and fall, so absorbing vibration when running over bad surfaces, but the arrangement is such that the tractor could still operate even if a spring should break.



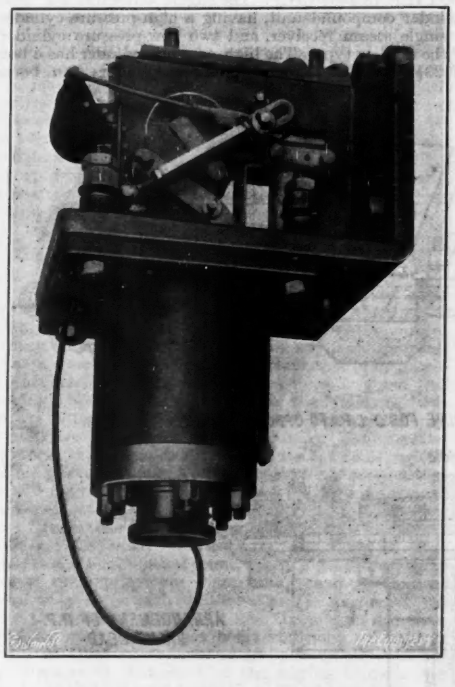
NEW CATERPILLAR TRACTOR



ARTICULATION OF THE BOGIES

Thermal Gas Closing Mechanism for Oil Circuit Breakers.

Although the practice of electrically closing circuit breakers was primarily adopted for the remote control of switchgear, it is now realised that where heavy currents have to be dealt with, and particularly under short-circuit conditions, hand closing is undesirable, and perhaps even dangerous. Some form of electrical or other closing mechanism is often advantageous, even if distant control is not desired, and Ferguson, Pailin, Ltd., of Higher Openshaw, Manchester, have therefore developed a thermal gas closing mechanism which can be applied to a circuit breaker and other arrangements which demand a rapid and powerful operating stroke. While direct-current solenoids, motor-closing mechanisms, &c., provide the power and rapid operation necessary for closing breakers under ordinary and fault conditions, it often happens that the cost of a storage battery and charging equipment or other source of electrical power is a serious item in the cost of the installation. The thermal gas closing mechanism shown in the accompanying illustration, however, merely calls for a small capacity battery, which may be of the dry Leclanche type. Alternatively, a small bell transformer may be used, and operating costs are therefore very small, and allow the device to be applied to a single circuit breaker.



THERMAL GAS CLOSING MECHANISM

The device consists mainly of one of the makers' type "C" free-handle closing mechanisms, in which the connection between the operating plunger and the circuit breaker is made by a compressed chain operating through a chain race, one side of which being removed when the trip coils operate, causes the chain to collapse and sets the breaker free to open. In the case of the mechanism under consideration, however, the usual solenoid is replaced by a steel expansion chamber, which is fixed to the "trip free" mechanism by means of a shock-absorbing device in the form of strong compression springs surrounding the bolts which clamp the broad top flange of the chamber to the underside of the base plate of the trip mechanism.

Inside the expansion chamber there is a spring-loaded plunger connected by means of the chain coupling to the circuit breaker mechanism, while in the bottom plate of the chamber there is a tapped hole for the closing element receptacle. The element consists of a cone-shaped container made of thin metal, and is filled with a small quantity of material which gasifies at a temperature of approximately 300 deg. Cent. A small heater strip or wire passes from one side of the metal container to a lightly insulated pin, which projects from the end of the cone. This pin passes through the steel plug screwed into the base plate of the expansion chamber to form the receptacle for the closing element. Connection is made to the heater by means of a flexible lead attached to a wood plug secured in position in a bayonet cap underneath the steel plug at the base of the chamber, and a spring-loaded contact on the plug makes contact with the insulated pin of the closing element.

The device is operated by passing a small current through the heater, which instantly attains a temperature of approximately 300 deg. Cent., and the rapid gas expansion which ensues propels the closing plunger and at the same time compresses the springs holding the expansion chamber to the trip mechanism. The effect is to store up some of the initial energy due to the charge, so that a fairly uniform propelling force is applied to the plunger throughout the stroke, and at the same time the expansion chamber is safeguarded against the consequences of the very high initial pressure which would otherwise be developed. A small vent at the base of the expansion chamber terminates at the end of a small bore tube with a fine gauze cage, which precludes any possibility of flame being emitted to the atmosphere, while the vent also allows the descending plunger to eject the products of combustion. The spring on the plunger is provided merely to ensure resetting of the mechanism and to complete the expansion of the gases. After each closing stroke the closing element has to be renewed, but as the elements are inexpensive and as the renewal operations can be effected in less than two minutes, this is not a real disadvantage.

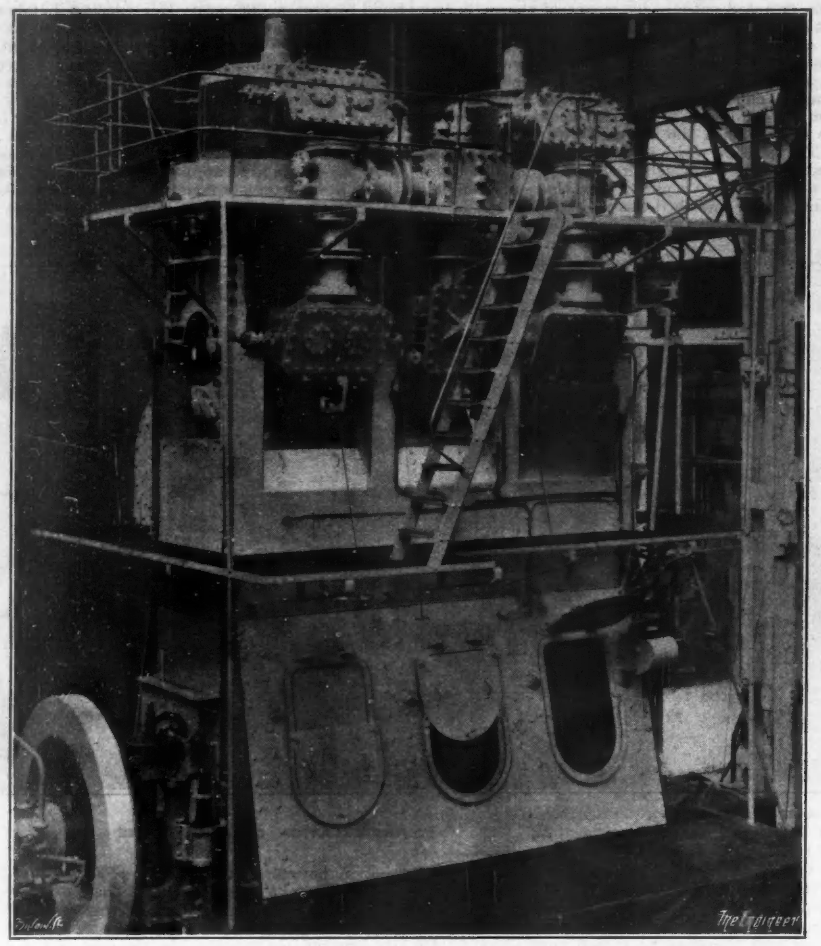
CONTRACTS.

Sir W. G. Armstrong, Whitworth and Co., of Newcastle-upon-Tyne, have received an order from Messrs. Henckell du Buisson and Co. for a 12-ton 95 B.H.P. oil-electric locomotive for use at the sugar cane plantations and works of the St. Kitts (Basse Terre) Sugar Factory, West Indies.

The Council of the Institution of Sanitary Engineers has nominated Mr. Godfrey M. C. Taylor, M. Inst. C.E., F.R. San. I., F.I.S.E., M. Inst. W.E., as President of the Institution for 1934.

THREE-CYLINDER SEMI-UNIFLOW STEAM ENGINE

ALEXANDER STEPHEN AND SONS, LTD., LINTHOUSE, ENGINEERS



2000 I.H.P. Marine Steam Engine.

On Tuesday of this week, October 24th, we were invited to attend at the Linthouse engine works of Alexander Stephen and Sons, Ltd., at Glasgow, the test bed trials of the patented "Stephen" three-cylinder compound marine steam engine, operating on the semi-uniflow principle. It has a designed output of 2000 I.H.P. The trials were continued during the three following days and will be resumed on Tuesday, November 7th, until Thursday, November 9th. The engine was exhibited in model form at the recent Olympia Exhibition, and some constructional parts of the valve gear were also shown. In what follows we describe some of the principal features of the new design, which has created a good deal of interest in marine engineering circles.

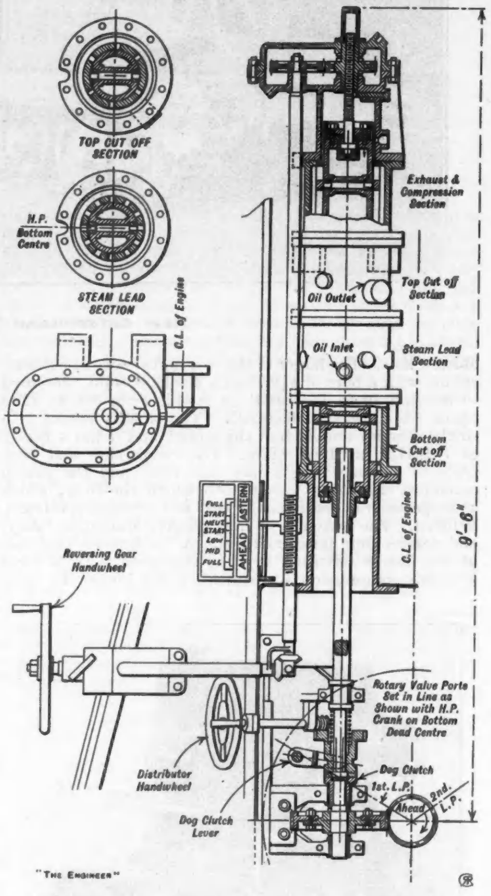
A view of the engine in the makers' works is given above, while below we reproduce drawings of the Stephen patented hydraulic valve operating gear and the low and high-pressure Andrews and Cameron slide valves. It may be recalled that the conversion of the engines of the s.s. "Annan," carried out last year, gave the designers an opportunity of investigating the possibilities of hydraulically driven Andrews and Cameron balanced slide valves. The "Annan" engine was fully described in our issue of August 19th, 1932, and its performance at sea in The Engineer of October 21st, 1932.

The new engine we are about to describe has been designed to embody the experience gained with the "Annan" engine with improvements which have resulted in a unit which is now available for powers from 500 I.H.P. to 3000 I.H.P. The engine under test is a three-cylinder compound unit, having a high-pressure cylinder, a single steam receiver, and two low-pressure cylinders of the uniflow type. The high-pressure cylinder has a bore of 23½in. and the two low-pressure cylinders 43in. bores, with a common stroke of 42in., the designed output being 2000 I.H.P. at 82 r.p.m. when supplied with steam at 230 lb. pressure and working under a vacuum of about 27in.

The constructional features include a fabricated steel frame with an all-welded crank pit. The main working stresses between the cylinders and the crank shaft are taken by heavy beams of H section, which are tied together in pairs, by the cast steel main bearing supports and the cast iron guide faces. The cylinders are rigidly held at their centres so that the top and bottom of each cylinder is free to expand, and expansion pieces of the bellows type are placed between the upper and lower valve boxes. The short crank case has a length of only 14ft. and a width of a little over 10ft., and a saving of about 20 per cent. in weight and length of the engine compared with a standard type of triple-expansion engine has been effected.

The engine is totally enclosed and is equipped with forced lubrication. A built-up balanced crank shaft is employed and the forged steel connecting-rods have cast steel top end bearings and white metal lined bottom end bearings. The crosshead guides have double shoes and are white metal lined with means for adjustment. The high-pressure cylinder is a steel casting with a liner of special cast iron, a cast iron piston being employed, and cast iron low-pressure cylinders are used with cast steel pistons carrying Ramsbottom hammered rings. As already indicated, the slide valves are of the Andrews and Cameron patented independent steam and exhaust quadruple opening balanced type with renewable seats, the hardened valve spindles working in ground glands without any packing.

The hydraulic gear, which is illustrated below, consists of a rotary distributor driven from the engine crank shaft and placed at the forward end of the engine, which is supplied with high-pressure operating oil from an independent pump. As shown in the engraving, in the distributor there are provided a number of ports which allow the oil pressure to be transmitted to small pistons on the ends of the various valve spindles, the valves being opened and closed by hydraulic pressure. The desired variation in the point of cut-off and correction for the lag in the system are obtained by sloping the ports in the casing of the distributor at an angle to the axis, while reversal is obtained by means of a second series of ports. In order to alter the cut-off or reverse it is only necessary to move the rotating plug axially in the casing. As the distributor is driven through gearing from the crank shaft and the oil pressure alone is used as a transmitter of power, the timing of the engine when once set cannot be disturbed. The discharge from the oil-operating distributor is finally led to the forced lubrication system of the engine.

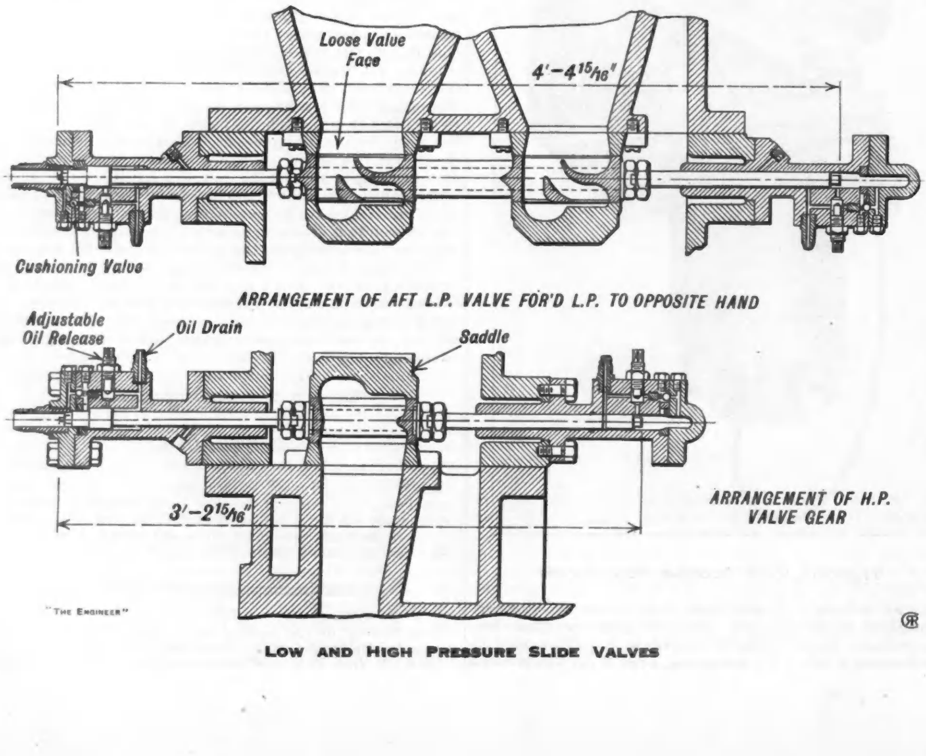


HYDRAULICALLY-OPERATED VALVE GEAR

The system is claimed to give early cut-off with quick opening and closing, while the compression and release are independent of the point of cut-off. Further, the cut-off is equal at the top and bottom of the cylinder, and the speed can conveniently be regulated by varying the cut-off. As will be seen from our illustration, a neat arrangement of control valves on the front of the engine has been arranged. The running parts and valve gear are made easy of access by means of large inspection doors and removable covers. A condenser of the regenerative type with a welded steel shell forms part of the equipment.

In a forthcoming issue we hope to give particulars of the preliminary trials.

During the last few weeks Professor A. L. Mellanby, of the Royal Technical College, Glasgow, has carried out an official set of bench trials, the results of which, it is hoped, will shortly be available for publication.



LOW AND HIGH PRESSURE SLIDE VALVES

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Steel Cartel's Difficulties.

The difficulties which beset the European Steel Cartel do not lessen with the passage of time. Although the differences between some of the merchants and the Cartel have been smoothed over, and an agreement has been reached with the Austrian, Czechoslovakian and Hungarian steel industries, limiting competition, the internal troubles of the Cartel have increased. The hostility felt by the distributors and merchants towards its sales policy, the confusion which exists with regard to prices, and the decline in the demand from the French and German home markets have combined to create something in the nature of a crisis in its affairs. The Belgian industry, which sells the greater part of its production for export, is the chief sufferer from the poor demand, and now that the French and Germans require their full share of the export trade, the comptoir responsible is faced with the impossible task of dividing the orders which come to hand in a way satisfactory to the various conflicting interests. The Belgian mills are reported to be working about three days a week, and it is natural that the steel makers strongly object to passing to other members of the Cartel orders which in the ordinary course would go to their own works. So high does feeling run that the chairman of the Clabecq Works, one of the most competitive works organisations on the Continent, told his shareholders at the annual meeting that the company had undertaken to give the Cartel a trial until the end of this year, and as a result their production had declined, their overhead charges had increased, so as to reduce profits, and they had also had to dismiss a number of workmen. If the situation did not improve, they would have to reclaim their independence. It is generally believed that if this company leaves the Cartel, the whole organisation and its selling arrangements will collapse.

A Dutch Government Contract.

The British steel makers have secured a valuable order for steel from the Dutch Government. An extensive scheme for bridge-building and bridge-repairing has been initiated in Holland which will be spread over several years, and contracts for a considerable proportion of the steel required for the first part of the programme have been placed in this country. Both high tensile and ordinary quality steel have been specified, and of the latter orders for about 2300 tons have been placed through the British Steel Export Association. It is expected that the higher quality steel requirements, amounting to about 3000 tons, will go to Dorman, Long and Co., Ltd., who will supply their Chromador steel. The Department of Overseas Trade announces that the following contracts are open for tender:—South African Railways and Harbours, twelve pump trolleys complete with wheels, axles, and ball bearings, 3ft. 6in. gauge, with a number of pressed steel wheels and axles, to be presented in Johannesburg by December 4th; steel angles, channels, flat bars, square bars, hexagon section round steel, and steel plates to specification C.M.E. 9/1930, to be presented in Johannesburg by November 13th; bolts, nuts and rivets, to be presented in Johannesburg by November 20th. A firm in Egypt requires supplies of brass wire for making hooks, 3·5 mm. and 6 mm. diameter; red copper bars, 2 cm. thick; copper flats, 15 mm. thick for rolling; wire-drawing Tombac metal bars, 2 cm. thick, and Tombac metal flat bars, 15 mm. thick. Egypt, Ministry of Education, weaving machines and accessories, also machine tools and workshop equipment, to be presented in Cairo by November 30th. Indian Stores Department, supply of ball and roller bearings for the year ending January 31st, 1935, to be presented in New Delhi by November 14th.

A Scottish Steel Plate Agreement.

The reorganisation of the Scottish steel industry has been advanced a further stage by the arrangement between Stewarts and Lloyds, Ltd., and Colvilles, Ltd., by which the latter take over Stewarts and Lloyds steel plate business in the home and export markets. Stewarts and Lloyds have manufactured plates for heavy pipe making and boiler plates at their Clydesdale Works at Mossend for some years. The agreement provides that over a period of years they will now receive the supplies they require for the manufacture of pipes from the Clydebridge Works of Colvilles, Ltd. The universal plate mill at Mossend will be converted into a blooming mill and transferred to the new steel works Stewarts and Lloyds are building at Corby, Northamptonshire. The firm will continue to develop the manufacture of large-sized tubes in Scotland, and as the capacity of the existing plate mills is in excess of the probable future demand it is expected that this concentration of production will enable a higher level of output to be reached at the Clydebridge Works. It is interesting to note that during the past few years Colvilles have, by taking over the businesses of competing firms, become of increasing importance in this branch of the steel industry, and as a result of this latest arrangement Colvilles, Ltd., and the Steel Company of Scotland, Ltd., are now the only two plate-producing interests in Scotland. It will be remembered that a year or two ago the plate business of Wm. Beardmore and Co., Ltd., was purchased and the works scrapped, whilst the plate business of James Dunlop and Co., Ltd., was also taken over by the Colville organisation. The new agreement will come into operation at the end of this year.

The Pig Iron Market.

The stocks of pig iron in makers' hands are being gradually reduced, but some time must elapse before the accumulations in some districts can be brought down to satisfactory proportions. Impatience is expressed in some quarters that the demand is not sufficient to absorb the stocks more quickly, and the old question of reviving the pig iron warrant market has been again raised. It is unlikely, however, that the pig iron producers would be unanimous on this question. It is doubtful if the makers on the North-East Coast would agree to put their stocks in warehouse and float warrants on the London and Glasgow markets, particularly as their situation so far as stocks are concerned is better than that of makers in other districts. The demand for Cleveland irons is steady and consumers have altered their attitude towards buying forward and would be willing to take more than the producers are prepared to sell owing to the advancing production costs. Good deliveries of foundry iron continue to be made to Scotland. The stocks have dropped to a level at which it is now necessary to give notice for iron which is required for shipment. In the Midlands the increased prices asked for coke and ore have once again brought to the fore the question of a possible increase in pig iron prices at the meeting of producers this week. Buying has been on a somewhat limited scale, but deliveries against contracts are being made and current business is sufficient to take care of the output. Business with the light castings foundries continues active and the heavy engineering concerns in the Midlands have shown more interest in the market. Conditions in Lancashire have also improved and there has been a tendency of late for buyers to order heavier tonnages. A certain amount of business has been done in Scottish irons at 79s. 6d. The quotation for Midland brands is unchanged, Northamptonshire foundry being 65s. 6d. West Coast hematite is quoted at 81s. In the Scottish market the demand for pig iron has been on a hand-to-mouth basis. The recent firmness which developed in the market for hematite has been maintained, and although prices have not further increased there is no inclination on the part of the makers to shade their quotations.

Finished Steel Materials.

If general business in finished steel materials is not on the scale of a few weeks ago, it has not deteriorated to a marked extent. The absence of any important new contracts has given the market a quieter appearance; but most of the steel works are busy, and the re-rollers have a considerable tonnage of work in hand. The improvement in the amount of shipping under construction is, of course, only comparative, and this industry at home and abroad is still passing through a period of depression. The figures given by Lloyd's Register of Shipping show that at the end of September the tonnage under construction in the world was 756,752 tons, of which 303,762 tons were credited to this country. Compared with the previous quarter, the figures showed an increase of 24,257 tons, of which Great Britain's share was 16,260 tons. These are encouraging figures, but the improvement must go much further before the steel makers benefit to any material extent. Even on the North-East Coast, where most departments are busy, the plate mills are short of work owing to the poor demand from the shipyards. In fact, the principal demand for shipbuilding steel comes from the repairing yards. The call for black sheets is steady, but these works also would benefit from new orders for ships. The constructional engineers on the North-East Coast are busy and Dorman, Long and Co.'s contract for the Storstrom Bridge is providing a considerable amount of work. The Scottish shipyards appear to be comparatively well employed and inquiries for new vessels are in circulation. The Scottish steel works lately have experienced an improved demand from the engineering trades, and there has been some expansion in business in tubes. Generally speaking, export trade remains unsatisfactory and the re-rollers of bars, sections, and hoops are finding competition severe from English works as well as from the Continent. The official price for re-rolled bars in this district is £7 5s. d/d Glasgow and £6 15s. f.o.b. In Lancashire the recent lull in buying has been succeeded by a demand on a fairly satisfactory scale, particularly from the constructional engineering firms. A feature of this business has been an increase in the weights ordered. The locomotive builders and the boilermakers are passing through lean times and the steel makers obtain little support from these industries. On the other hand, business in alloy steels continues to increase and the demand for bars for bright drawing is well maintained.

The Midlands, Yorkshire, and South Wales.

Conditions in the Midlands have improved lately and orders have been given out more freely than at the beginning of the month. The constructional engineers, however, do not seem to be working on any large contracts and as a consequence the demand from this branch consists of small parcels, which necessitate frequent roll changing. Some of the plate mills in the Midlands, however, are better off for work than in other districts, although the mills are by no means fully occupied. Boiler plates of either acid or basic quality are quoted at £8 5s., whilst chequer plates are at £10 7s. 6d. basis for home delivery and £10 for export. The position with regard to small steel bars is satisfactory and the re-rollers are asking rather higher figures than of late. A quotation of £7 is frequently heard and for small quantities 2s. 6d. extra is often demanded. On the other hand, when a good order is in question these prices are shaded, and recently business was taken by an English re-roller at £6 15s. in competition with a Continental seller at £6 10s., the margin in favour of the foreign material not being sufficient to make it attractive. The better demand for colliery material has been maintained, but most of the buying hitherto has been of a hand-to-mouth description. The decline in buying in the Yorkshire district was short-lived and business is again being transacted on a good scale. The call for tool steels is increasing, whilst the motor industry has provided a good outlet for special steels. The pressings and forgings departments also are more actively employed, partly on work in connection with the Imperial Chemical Company's low carbonisation plant. In South Wales the demand for tin-plates has been maintained at a high level. Recently, in one week 400,000 boxes were sold, which was well in excess of the week's production. The intimation that British (Guest, Keen and Baldwins) Iron and Steel Company, Ltd., intend to reconstruct the Dowlais Works at Cardiff at a cost of about £2,000,000 to provide a plant capable of producing 300,000 tons of billets and sheet bars per annum has created a feeling of optimism. The scheme is to be completed in about two years, and it is thought that the Cardiff Corporation will help the enterprise by giving the most advantageous terms possible in respect of the supply of water and power.

Copper.

A rather steadier tone has ruled in the copper market since the sharp fall in values towards the end of last week. After showing firmness in the face of the disturbing international political events, the market broke on a reduction in the American domestic price for electrolytic copper to 7½ c. d/d. The movement followed the strong pressure to sell by the Customs smelters in the United States, who found that at the price of 9 c., which had ruled for some time in the American market, they were accumulating stocks. Rather than do this, they broke the price. Their efforts to sell, however, were not very successful, since the fluctuations of the exchange, which occurred about the same time, made export business difficult, and consumers in the United States, as is usually the case on a falling market, were inclined to hold aloof. Continental buying has been poor, although some business has been done with Germany. The imports of copper into Germany for the first nine months of this year were estimated at 45 per cent. higher than for the corresponding period of last year, but it is believed that stocks in hand are not more than sufficient to keep consumers' works going for six to eight weeks. The German production of copper is also rising, and reached a total of 14,500 tons in September. These figures indicate the rather active conditions which have followed the German Government's development plans. The world's statistical position of the metal seems to be improving. American unofficial figures gave the stocks of refined copper at the end of September as 638,500 tons, compared with 653,000 tons at the end of August. The stocks in America on September 30th were 528,500 tons. Production of copper in the United States during September totalled 33,000 tons, whilst the rest of the world produced 63,000 tons. The London standard market speculation has decreased, and apparently most bull accounts have been liquidated. There has been some indication of bear selling, but speculation of this nature might be dangerous at the present price levels. In the early part of the week there was heavy selling on French account as a result of the political crisis in that country.

The Tin Market.

In this market the reaction which occurred last week has been followed by a firmer tone. Undoubtedly, however, the news from America has somewhat shaken confidence. The absence also of important buying by American consumers has tended to promote easier conditions in this market. It should be pointed out, however, that American dealers and consumers purchase at intervals fair quantities of tin, although the continuous buying which characterised the position a few months ago is now a thing of the past. Apart from disturbing influences arising from international, political and financial events, this market is in a strong position. Expectations that the International Tin Committee will authorise an increase in production to 40 per cent. from the present 33⅓ per cent., even if fulfilled, are not likely to exercise a depressing influence, since it is thought that the increase will not come into force until next January, and in the meantime the statistical position is steadily strengthening. Stocks in this country are being reduced, and there is talk of a possible stringency arising in the last part of the year. The demand from the consuming trades has been steady, but in many cases users have covered their requirements. German statistics show that the increased production of tin-plates in that country has been largely responsible for the heavier imports of tin which, during the first nine months of this year, were 100 per cent. higher than in the corresponding period of last year.

Lead and Spelter.

Prices in the lead market have moved within a narrow margin, although a trace of nervousness was observable in the early part of the week. Consumers are still holding aloof from the market, but it is generally thought that buying for industrial purposes will expand later in the year, as the request for manufactured lead materials is being well maintained. On the other hand, with the approach of winter building operations, which are largely responsible for the heavy demand for pipes and sheets, may be expected to slow down. It is interesting to note that producers of lead are showing more inclination to deal with merchants than for some time, and this, no doubt, has helped to keep prices steady. At one time the producers were inclined to ignore the merchants in an effort to do a direct trade, but latterly there seems to have been a change in this policy. . . . In the spelter market prices have eased somewhat in sympathy with other metals, but improved later on better advices from America regarding general conditions there. Fundamentally, however, the market is unchanged, and the statistical position is regarded as being good, all things considered. Reports from the Continent indicate that there is still a good demand for finished materials like zinc sheets, and that there has been little diminution in the consumption of spelter.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 0 0	3 0 0
No. 1	3 0 6	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
Midlands—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ $\frac{5}{16}$in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ $\frac{3}{16}$in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in.	8 15 0	7 15 0
„ $\frac{5}{16}$in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ $\frac{3}{16}$in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ $\frac{5}{16}$in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ $\frac{3}{16}$in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ $\frac{5}{16}$in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ $\frac{3}{16}$in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ $\frac{5}{16}$in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ $\frac{3}{16}$in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ $\frac{5}{16}$in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ $\frac{3}{16}$in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 17/–.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	5 15 0
„ Medium (0·42% to 0·60% C.)	6 12 6
„ Hard (0·61% to 0·85% C.)	7 2 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 25% C.), 500 tons and up	5 2 6
100 tons	5 10 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/7 per lb.	
Ferro Tungsten	2/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 17 6	7/–
„ „ 6 p.c. to 8 p.c.	£19 7 6	7/–
„ „ 8 p.c. to 10 p.c.	£18 17 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£29 15 0	9/–
„ „ „ 1 p.c. carbon	£30 17 6	10/–
„ „ „ 0·70 p.c. carbon	£35 5 0	12/6
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£18 2 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, October 25th.

Copper—		
Cash	£33 8 9 to £33 10 0	
Three months	£33 11 3 to £33 12 6	
Electrolytic	£36 10 0 to £37 5 0	
Best Selected Ingots, d/d Birmingham	£37 0 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
Brass—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£223 17 6 to £224 0 0	
Three months	£223 12 6 to £223 15 0	
Lead:	£11 18 9 to £12 3 9	
Spelter:	£16 0 0 to £16 6 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

		Export.
Lanarkshire—		
(f.o.b. Grangemouth)—Navigation Unscreened		12/6 to 13/–
„ Glasgow—Ell		12/6 to 14/–
„ „ Splint		14/9 to 15/–
Ayrshire—		
(f.o.b. Ports)—Steam		12/–
Fifeshire—		
(f.o.b. Methil or Burntisland)—Steam		13/6 to 14/–
Unscreened Navigation		12/3 to 13/–
Lothians—		
(f.o.b. Leith)—Hartley Prime		13/– to 13/6
Secondary Steam		13/–

ENGLAND.

	Inland.	
Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/6 to 20/6
Furnace Coke		13/– to 17/6
Northumberland—		
Best Steams		13/9 to 14/–
Second Steams		12/9 to 13/–
Steam Smalls		10/–
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/6
Foundry Coke		17/– to 18/6
Sheffield—	Inland.	
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	8/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	19/– to 36/–
Furnace Coke	15/– to 17/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	10/– to 11/–
Steam Coals:	
Large	18/– to 20/6
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Electricity Supply.

On the occasion of the Industrial Heating Congress visits were made to the power stations at Vitry-Sud and St.-Denis, which form part of the electrical generating system around Paris, other important stations being Gennevilliers, St.-Ouen, and Issy. When the greater part of the system came under the control of the Union d'Electricité, there was a proviso that no further extensions should be made to existing stations except St.-Denis, and the new station at Vitry-Sud was laid out with a view to the installation being increased eventually to 500,000 kW. The first part of the programme was completed last year, when Vitry-Sud started with four turbo-alternators producing a total of 220,000 kW. Being the latest big power heat station constructed in this country, it is noteworthy in being equipped with the most efficient labour-saving plant and machinery procurable in France and abroad. In view of the comparison that was made at the Industrial Heating Congress between the wages bills of heat and hydro-electric plants, when it was declared that heat power generating stations were of more value to the community than the hydraulic supply, it is interesting to observe the extent to which the practically automatic working of a modern heat power plant has reduced labour to a minimum. The coal is handled by one man, and a battery of steam generators, fired with pulverised coal, is supervised by another. Although provision is made for an extension of the power station, it is by no means certain that this will be done in the near future. No one can foresee what is likely to be the consumption of electricity in the Paris district. For the moment, the supply largely exceeds the demand, and now that the quantity available from the Massif Central, Eguzon, and other hydraulic centres is expected to be supplemented in about two years' time by a further supply from Kembs, there is no necessity to proceed with the programme of extensions to Paris stations which can only be regarded as a possible contingency. Any further extension of the St.-Denis power station is held up for that reason. The old St.-Denis generating installation was put down about thirty years ago for the requirements of the Paris Metropolitan Railway, but those requirements are now served by the linking up of all the power stations in conjunction with the hydro-electric supply. The new St.-Denis power station adjoining the old one has a modern equipment similar to that of Vitry-Sud, though on a smaller scale.

Public Works.

The programme of public works comprises only a small part of the "Economic and Social Equipment" scheme which the Government has prepared, and which will be discussed in Parliament shortly. Out of the proposed total expenditure over a period of four years of 13,736 million francs, nearly one-half of which will be contributed by local bodies, the amount devoted to public works will be 2279 million francs. This will be additional to the sums provided for in the Budget estimates. These normal expenses include a contribution of 12,000,000f. towards the suppression of level crossings, and it is noteworthy that the shipping subsidies for the coming year total 126,700,000f. A large amount will also be devoted to aviation, to which a great impetus has been given since the amalgamation of the five companies into a semi-State company known as "Air-France," that has been definitely constituted with a board of directors composed of thirty-six members, including nine appointed by the State. It comprises representatives of railway and shipping companies, finance, Colonial Governments, the aircraft industry, and the Suez Canal Company. A part of the funds will be employed to equip landing grounds, and will also serve to create an air line between France and the Belgian Congo, with an extension eventually to Madagascar. This enterprise was to have been initiated a year ago in collaboration with the Belgian air organisation, but at that time the French Government was unable to ensure the service across the Sahara Desert.

Export Trade.

While the monthly returns of foreign trade continue to show a steady decline in imports and exports, the latter having contracted by 1094 million francs during the first nine months of the year, as compared with the similar period of 1932, the proportion of colonial trade included in these figures naturally becomes more important, and represents 27 per cent. of the total imports and nearly one-half of the exports. This leaves the value of exports to foreign countries during the nine months at something like 7000 million francs. The situation is so unsatisfactory that the Association des Grands Ports Français has appealed to the Government not to impose further restrictions on foreign exchanges before attempting to negotiate with other countries. Otherwise, it affirms, the policy now pursued will destroy what foreign trade there is left. The fact that France has followed the example of Sweden, Holland, and the Irish Free State in denouncing the tariff truce, implies the intention of the Government to carry through such negotiations if it possibly can.

The Steel Trade.

Instead of the customary revival of activity at this time of the year, the iron and steel trades display a decided retrograde tendency, accompanied by a decline in the pig iron and raw steel production which has, until recently, been well maintained for export. French steelmakers have exceeded their quota for the present three months, and on the home market the demand is steadily falling, to the extent that the future is not encouraging unless hope can be entertained that enterprise will revive with the heavy expenditure it is proposed to make on public works. Apart from the general financial and economic depression, there is a risk of complications within the Steel Cartel if the Forges de Clabecq should carry out its threat to withdraw from the Union at the end of the year. It is believed that, in the general interests of the steel industry, some way will be found of adjusting the difficulty.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

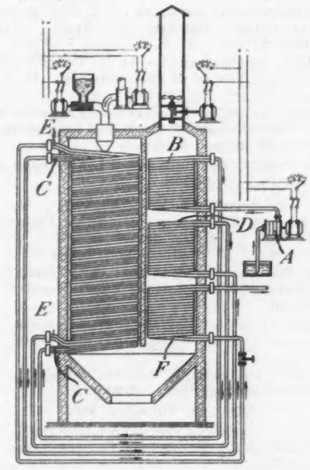
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

398,413. February 27th, 1933.—Critical Pressure Vapour Generators, Siemens-Schukertwerke Aktiengesellschaft, Berlin-Siemensstadt, Germany.

This is a rather interesting specification, in which it is explained that one of the troubles with steam generators of the critical pressure type is what might be described as "gulping" (not so mentioned in the specification); that is to say, the position in the coil of piping forming the boiler, at which the water changes from the liquid to the vaporous form, may fluctuate on account of changes in the flame temperature and length. The result is obviously a discontinuity in the steam supply. The inventors overcome the difficulty in the following manner:—Water at the necessary critical pressure is supplied to the boiler by the pump A. It is passed through a preheater B and then goes to the coil C of the main generator. After passing through this coil it goes at or about the critical temperature to the coil D, which is described as a "transition heating element." The resultant vapour returns to a parallel coil E in the main combustion chamber, and is finally superheated at F. If will be noticed that the first and second passes of the coil through the combustion chamber are subject to practically identical heating conditions, so that changes in the furnace conditions do not have a material influence on the ultimate product.—*September 14th*, 1933.

Nº398,413

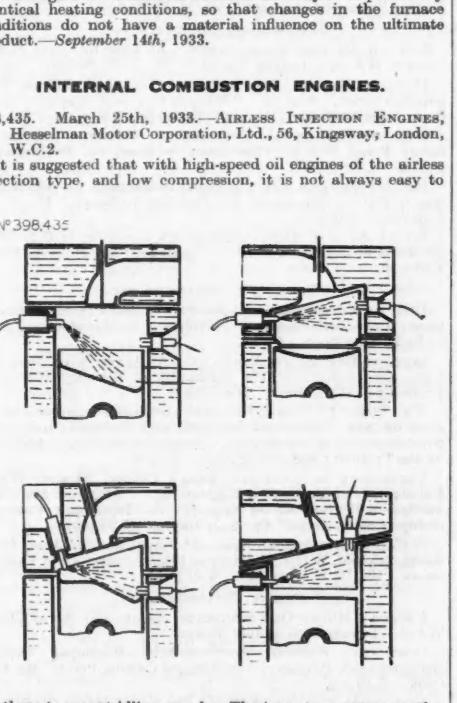


INTERNAL COMBUSTION ENGINES.

398,435. March 25th, 1933.—Airless Injection Engines, Hesselman Motor Corporation, Ltd., 56, Kingsway, London, W.C.2.

It is suggested that with high-speed oil engines of the airless injection type, and low compression, it is not always easy to get them to run at idling speeds. The inventors, consequently, suggest a combustion space formed as an obliquely truncated cylinder, with the injection nozzle towards the apex and the sparking plug at the larger end. The drawings illustrate several alternative arrangements.—*September 14th*, 1933.

Nº398,435



TRANSMISSION OF POWER.

397,539. February 23rd, 1932.—Electric Cable Systems, Siemens Brothers and Co., Ltd., of Caxton House, Tothill-street, S.W.1, and Henry Gurney Wood, of "Kinross," Leesons Hill, Chislehurst, Kent.

This specification describes a joint casing box or sleeve to be used in covering the place of jointing in a cable system, and which allows for expansions or contractions of the lead sheathing and for expansion of oil, compound, or other filling medium within the casing. The cables A may be three-core or other cables, which are prepared for jointing in the usual manner. The corrugated member B may be composed of thin metal, such as copper and is threaded on to each cable. A joint sleeve C, which may also be of thin metal, such as copper, is threaded on to one of the cables. The members B are corrugated circumferentially, as shown in section in Fig. 1, and the joint sleeve is corrugated radially, as shown in transverse section in Fig. 2. When the cable is jointed the joint sleeve C and the two members B are welded or plumbed together, as shown at D and each member D is plumbed or otherwise connected to the sheathing A of its respective cable, all jointings as D and E being leak-proof. With this arrangement longitudinal and radial expansions and contractions of the cable and of the joint filling material, due to heating and so forth, are taken up.—*August 23rd*, 1933.

Nº397,539

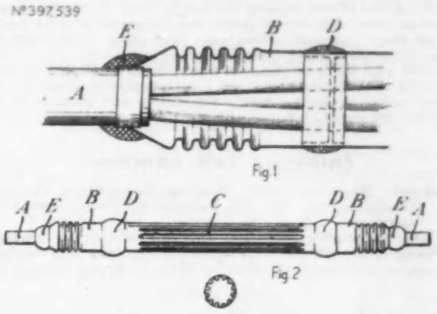


Fig 1

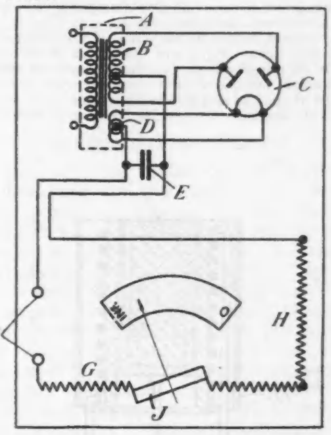
Fig 2

MEASURING AND TESTING INSTRUMENTS.

397,563. March 2nd, 1932.—Measuring Electrical Resistance, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Henry Cobden Turner and Arthur Sherwin, both of Salford Electrical Instruments, Ltd., Peel Works, Silk-street, Salford, Lancashire.

The megohm meter of the resistance measuring apparatus described in this specification comprises a transformer A, the secondary B of which is associated with a double-wave rectifier C. An auxiliary secondary D provides current for heating the cathode of the rectifier, and a condenser E serves for smoothing the uni-directional voltage derived from the rectifier. The test leads are connected to the terminals F. G and H are resistances, and J the moving element of a sensitive milli-ammeter with a scale calibrated at one end in thousands of ohms, and at the other end in megohms—extending to infinity. The resistance H may be adjusted to compensate for variations in the A.C. voltage. Means may also be provided for making the rectifier serve for use on mains of different voltages. As when using the apparatus no handle has to be turned, the operator can give his full attention to the test, and can manipulate the testing spikes with ease.—*August 31st*, 1933.

Nº397,563

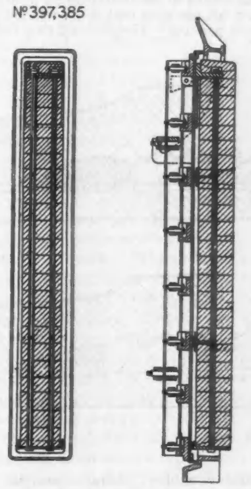


GAS PRODUCERS.

397,385. February 13th, 1933.—Coke Oven Doors, *W. W. Groves*, 30, *Southampton-buildings, London, W.C.2.*

This invention relates to a self-tightening coke oven door of the kind consisting of an outer door constructed as an elastic plate and protected on the side exposed to radiation by an inner door of fire-brick. The protecting brickwork door is suspended from a support fixed to the elastic door plate and connected with the protecting door only at the upper end thereof. The preferred support is a bracket, from which are suspended iron rods extending through the brickwork and carrying at their lower

Nº397,385



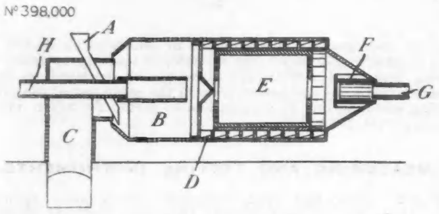
ends a supporting plate on which the weight of the brickwork rests. The brickwork may consist of separate superimposed blocks of the necessary cross section. Any iron supporting frame in which the brickwork is contained is rendered unnecessary by this arrangement so that the weight of the door is reduced. The rods are connected with the bracket in such a manner that the brickwork can swing to a certain extent about the position of rest, and by the arrangement of a suitable projection between the lower part of the door plate and the brickwork there is secured a free space between the brickwork and the elastic plate which permits bending of the door plate. Connected with the door plate are iron rods which engage by their hooked ends the rods by which the brickwork is suspended, so that undue oscillation during the closing and opening of the door is prevented.—*August 24th*, 1933.

CRUSHING AND GRINDING.

398,000. June 23rd, 1932.—Ball or Tube Mills, Ofenbau-Gesellschaft m.b.H., 105, Kaiserswerthstrasse, Düsseldorf, Germany.

This invention is concerned with ball mills of the dry type. The material to be ground is fed into the mill through the shoot A and is subjected in the chamber B to the drying action of hot gases supplied by the duct C. The material is picked up by the scoops D and fed into the grinding chamber E. The gases and suspended matter are drawn off through the filter F at G. After the suspended matter has been separated out from the gases they are returned to the circuit at H in such a zone that they do not militate against the drying action of the hot gases coming in at C.—*September 7th*, 1933.

Nº 398,000

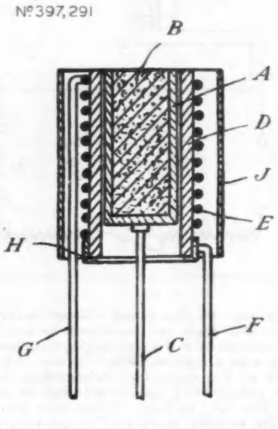


MISCELLANEOUS.

397,291. July 15th, 1932.—Electric Discharge Devices, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, U.S.A.*

This invention relates to cathodes of the electron emitting and indirectly heated type, and the object of the invention is to provide an improved construction of cathode and a simple and economical method of manufacture. A is a small nickel tube closed at one end and filled with a compressed mixture B of barium oxide and tungsten powder. The small nickel tube is so positioned that its open end points in the direction in which the electron emission is to take place. The tube A has a cathode lead C, which may also serve the purpose of a support. This tube A is also surrounded by a small quartz tube D, which carries a tungsten coil E. The spiral has two current leads F and G. The lead F is attached to a wire ring H bent around the other end of the small quartz tube so that the latter is supported by the lead F. If necessary, the heating coil may be surrounded by a reflector J. The method of manufacture is described.—*August 24th*, 1933.

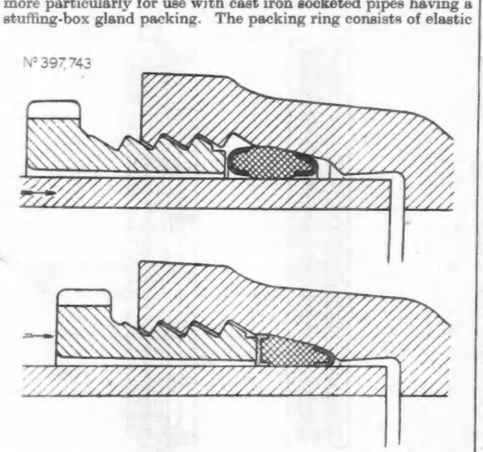
Nº 397,291



397,743. December 21st, 1932.—A Packing Ring for Pipe Joints, Vereinigte Stahlwerke Aktiengesellschaft, Breitestr. 67/69, Düsseldorf, Germany.

This invention relates to packing rings for pipe joints intended more particularly for use with cast iron socketed pipes having a stuffing-box gland packing. The packing ring consists of elastic material, preferably rubber, characterised in that its cross section has substantially the shape of a rhombus whose opposite corners, which are in transverse relation to the axis of the ring, become deformed when it is inserted in the stuffing-box and before the stuffing-box gland packing is tightened. The packing is, of course, made still more complete when the stuffing-box gland is inserted in the already known manner. In order to protect the packing from damage, either by the contents of the pipe or by the pressure of the stuffing-box gland, and also in order to facilitate the insertion of the latter, the axially directed edges of the ring are covered with an outer lining of a deformable material, such, for example, as lead. The illustrations show the packing before it is deformed and after the gland has been tightened up.—*August 31st*, 1933.

Nº 397,743



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.

To-day.

Inst. of Chemical Engineers.—At Inst. of Civil Engineers, Great George-street, S.W.1. "Engineering in the Service of Chemical Research," Professor G. T. Morgan. 6.30 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. General meeting. Presidential address, Mr. Alan E. L. Chorlton. 6 p.m.

Inst. of Structural Engineers: Midlands.—James Watt Memorial Inst., Birmingham. Chairman's address, Mr. E. L. Cotterell. 6.30 p.m.

Inst. of Electrical Engineers: N.E. Centre Students.—At Armstrong College, Newcastle-upon-Tyne. "The Dunston 50-cycle Power Station," Mr. A. S. Carr. 7.15 p.m.

Junior Inst. of Engineers.—At 39, Victoria-street, S.W.1. "The Electrolytic Theory of Corrosion," Mr. H. E. Yerbury. 7.30 p.m.

Manchester Assoc. of Engineers.—Engineers' Club, Manchester. "The Selection of Steels for Engineering Requirements," Mr. F. W. Rowe. 7.15 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse, Mr. E. V. Appleton. 9 p.m.

Saturday, October 28th.

Hull Assoc. of Engineers.—Municipal Technical College, Park-street, Hull. "Experimental Research on Boundary Lubrication," Mr. J. E. Southcombe. 7.30 p.m.

Inst. of British Foundrymen.—The Technical College, Derby. "Technical Control in the Small Foundry," Mr. J. G. Pearce. 6 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. "The Course and Causes of the World Depression," Mr. L. C. Robbins. 3 p.m.

Stephenson Locomotive Society.—Visit to Stratford, L.N.E. Railway Running Sheds. 2.30 p.m.

Monday, October 30th.

Bradford Engineering Soc.—Technical College, Bradford. "Salvage Work on the Ex-German Fleet at Scapa Flow," Mr. E. F. Cox. 7.30 p.m.

Inst. of Automobile Engineers.—At 39, Elmbank-crescent, Glasgow. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 7.30 p.m.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Stainless Steels in Aeroplane Structures," Mr. F. J. Murdoch. 6.45 p.m.

Tuesday, October 31st.

Inst. of Transport.—At Inst. of Electrical Engineers, Victoria Embankment, W.C.2. Discussion, "The Duties of a Modern Transport Manager," Mr. M. F. Barnard.

Wednesday, November 1st.

Inst. of British Foundrymen.—At Charing Cross Hotel, London, W.C.2. "Cupola Practice," Mr. L. W. Bolton. 8 p.m.

Inst. of British Foundrymen.—Technical College, Corporation-street, Preston. "Manufacture and Application of Centrifugal Castings," Mr. T. R. Twigger. 7.30 p.m.

Inst. of Electrical Engineers: Wireless Section.—Savoy Place, W.C.2. Chairman's address, Mr. G. Shearing. 6 p.m.

Inst. of Physics.—In the Royal Institution, 21, Albemarle-street, W.1. "Physics in the Building Industry," Dr. R. E Stradling. 5.30 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. Presentation of medals. Address, "Quality," Mr. John A. Milne. 8.30 p.m.

Thursday, November 2nd.

Inst. of Automobile Engineers.—Queen's Hotel, Birmingham. Presidential address, "Problems in Manufacture," Mr. C. R. F. Engelbach. 8 p.m.

Inst. of British Foundrymen.—At James Watt Memorial Inst., Birmingham. "The Education of Foundry Workers," Professor J. H. Andrew. 7.30 p.m.

N.E. Coast Inst. of Engineers and Shipbuilders: Teesside Branch.—Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. Inaugural meeting. Addresses by the President and Chairman. 7.30 p.m.

University of London.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: iii., Injection: Processes in Injection Systems," Dr. S. J. Davies. 5.30 p.m.

Royal Aeronautical Soc.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Variable Pitch Airscrews and Variable Gears," Mr. W. G. Jennings. 6.30 p.m.

Friday, November 3rd.

Faraday House Old Students' Assoc.—At Savoy Hotel, W.C.2. Twenty-fifth annual dinner.

Inst. of British Foundrymen.—Municipal College, Ormerod-road, Burnley. "Continuous Casting Plant," Mr. F. J. Cook. 7.15 p.m.

Inst. of Marine Engineers.—Grosvenor House, Park-lane, W.1. Annual conversazione. 7 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Thomas Hawksley Lecture, "Kinematic Design in Engineering," Professor A. F. C. Pollard. 6 p.m.

Inst. of Production Engineers: London Section.—83, Pall Mall, S.W.1. "Modern Production Acetylene," Mr. C. Helsby. 7.30 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Safety and Efficiency in Electrical Installation Work," Mr. W. F. C. Cooper. 7.30 p.m.

N.E. Coast Inst. of Engineers and Shipbuilders.—In Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. Andrew Laing Lecture, "Recent Metallurgical Developments and their Significance for Shipbuilding and Marine Engineering," Prof. F. C. Lea. 7 p.m.

Railway Club.—57, Fetter-lane, E.C.4. "Train Ferries: Their History and Development," Mr. S. R. Yates. 7.30 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse, Sir Arthur Hill. 9 p.m.

Saturday, November 4th.

Inst. of British Foundrymen.—At Engineers' Club, Manchester. "Continuous Casting Plant," Mr. F. J. Cook. 4 p.m.

Inst. of Electrical Engineers: North Midland Students.—Visit to the Hunslet Engine Company, Ltd., Jack-lane, Leeds. Meet at Corn Exchange, Leeds, 2.30 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. "The Course and Causes of the World Depression," Mr. L. C. Robbins. 3 p.m.

Monday, November 6th.

Soc. of Engineers.—In the Rooms of the Geological Soc., Burlington House, W.1. "Nasmyth: Father and Son," Mr. John Wilkie. 6 p.m.

Wolverhampton and District Engineering Soc.—The Co-operative Hall, Stafford-street, Wolverhampton. The Thomas Lowe Gray Lecture, "Eight Years' Salvage Work at Scapa Flow," Mr. E. F. Cox. 7.30 p.m.

Tuesday, November 7th.

Inst. of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow, C.2. "Liquid Fuels from Coal for Naval Purposes," Eng.-Capt. S. H. Dunlop, R.N. 7.30 p.m.

Inst. of Metals: Birmingham Local Section.—In the Girls' High School, Dudley. "The Interpretation of a Photomicrograph," Mr. J. W. Jones. 7 p.m.

Tuesday and Wednesday, November 7th and 8th.

Inst. of Gas Engineers.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Fifth autumn research meeting. Morning sessions, 10 a.m.; afternoon sessions, 2.30 p.m. (See page 406.)

Wednesday, November 8th.

Soc. of Glass Technology: London Section.—Visit to Canning Town Glass Works, Stephenson-street, Canning Town, E.16. 7.30 p.m.

Thursday, November 9th.

Chemical Engineering Group.—Joint meeting with the Oil and Colour Chemists' Assoc. at Inst. of Chemistry, 30, Russell-square, W.C.1. Discussion, "Function of Paint as a Metal Preservative." Opener, Dr. L. A. Jordan. 7.30 p.m.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. Junior Section. "Pumps for Marine Service," Mr. F. M. Jones. 7 p.m.

Inst. of Civil Engineers: Birmingham and District Assoc.—At James Watt Memorial Inst., York House, Birmingham. "Rainfall as of Interest to Engineers," Mr. A. A. Barnes. 6 p.m.

Inst. of Structural Engineers: Yorkshire.—Hotel Metropole, Leeds. "Designing for Welding," Mr. C. Helsby. 7 p.m.

Inst. of Metals: London Local Section.—At Royal School of Mines, S. Kensington. "Gold—its Sources and Production," Mr. R. Annan. 8 p.m.

University of London.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: iv., Injection: Processes in the Cylinder," Dr. S. J. Davies. 5.30 p.m.

Friday, November 10th.

Inst. of British Foundrymen.—At the Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. "Routine Methods of Testing Green Sands," Mr. N. D. Ridsdale. 7.45 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Discussion, "Financing Industry," introduced by Mr. Sydney Parkes. 7 p.m.

Inst. of Metals: Sheffield Local Section.—In Non-ferrous Section of Applied Science Department of University, St. George's-square, Sheffield. "Metal Spraying," Mr. W. E. Ballard. 7.30 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Annual general meeting. 7.30 p.m.

Saturday, November 11th.

Inst. of British Foundrymen.—Technical College, Monks-road, Lincoln. "Use of Refractory Materials in the Foundry," Dr. J. G. A. Skerl. 7 p.m.

Inst. of Marine Engineers: Junior Section.—85–88, The Minories, E.C.3. Social and dance. 7.30 p.m.–11.15 p.m.

Inst. of Mech. Engineers: Graduates.—Visit to Brookman's Park Wireless Station. Particulars from Hon. Sec., Graduates' Section, 28, Essex street, Strand, W.C.2.

Monday, November 13th, to Saturday, November 18th.

Public Works Congress and Exhibition.—Agricultural Hall, Islington, N.1. Daily. (For programme see page 365).

Monday, November 13th.

Inst. of Metals: Scottish Local Section.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Discussion on papers presented at the autumn meeting of the parent Institute. 7.30 p.m.

Tuesday, November 14th.

Chemical Engineering Group.—At the Public Works, Roads, and Transport Exhibition, Royal Agricultural Hall, Islington, N.1. Conference, "The Mechanical Testing of Bituminous Road Materials." Sessions 11 a.m. and 3 p.m.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. "Welding for Pressure Vessels," Mr. R. Sulzer. 6 p.m.

Inst. of Metals: Birmingham Local Section.—In James Watt Memorial Inst., Birmingham. "Deoxidisers and Fluxes," Mr. G. L. Bailey. 7 p.m.

Inst. of Metals: N.E. Coast Local Section.—Joint meeting with the Newcastle-upon-Tyne Branch of Soc. of Chemical Industry, in Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. "Metal Spraying," Mr. W. E. Ballard. 7.30 p.m.

Inst. of Metals: Swansea Local Section.—At Y.M.C.A., Swansea. "Ageing and Age Hardening," Dr. Cecil H. Desch, F.R.S. 6.15 p.m.

Wednesday, November 15th.

Inst. of Electrical Engineers: Meter and Instrument Section.—Pagani's Restaurant, 42, Gt. Portland-street, W.1. Annual dinner. 6.45 p.m. for 7 p.m.

Manchester Metallurgical Soc.—At College of Technology, Manchester. "Hardness of Metals," Dr. H. O'Neill. 7 p.m.

N.E. Coast Inst. of Engineers and Shipbuilders: Graduates.—Bolbec Hall, Newcastle-upon-Tyne. "Leaves from an Engineer's Log," Eng.-Comr. C. J. Hawkes, R.N. 7.15 p.m.

Thursday, November 16th.

British Waterworks Assoc.—Agricultural Hall, Islington, N.1. To receive and discuss the following papers:—"Pooling of Supplies by Interconnection of Water Undertakings and their Trunk Mains through Rural Areas," Mr. Alan E. L. Chorlton; "Water Pollution Research," Dr. A. Parker. 11 a.m. Afternoon session: "The Financial Management of Municipal Trading Departments," Mr. Sydney Larkin; "Water Supply and Fire Protection," Mr. John Smith; "Fire Prevention and Fire Extinguishing Apparatus," Major F. W. Jackson; "The Legal Aspect of Water Supply for Fire Protection Purposes," Mr. John Hall. 2.45 p.m.

A Seven-Day Journal

Cast Iron Research.

The report of the British Cast Iron Research Association, which has just been issued, reviews the progress made during the last year, and shows a steady increase in the volume of work performed. The increased laboratory accommodation at headquarters has been of great assistance in advancing the work undertaken, and quite recently more floor space for laboratories has been acquired and will enable the Association to meet normal requirements for some years to come. By the offer of Mr. H. James Yates, the chairman of Radiation, Ltd., and a Vice-president of the Association, to provide funds to erect an experimental cupola furnace, a long-needed want has now been met. The furnace will be erected at a small foundry near to the laboratories under conditions which will enable it to be operated on an experimental basis at any time, without the necessity of the Association permanently maintaining the manual labour. The new facilities which the furnace will offer will, it is expected, greatly advance the value of the work carried out, not only by the Melting Practice Subcommittee, but also of other sub-committees of the Association. The new President of the Association is Major F. A. Freeth, D.Sc., F.R.S., of Imperial Chemical Industries, Ltd., who has consented to accept the office lately relinquished by Sir Harold Hartley. In view of the extensive application of cast ferrous metals and alloys in the chemical industry, Dr. Freeth's appointment would seem to be a most appropriate one. The re-elected chairman of the Association is Mr. H. B. Weeks, F.I.C., and the Vice-chairmen Mr. J. T. Goodwin and Mr. F. J. Cook, M.I. Mech. E.

The Parliamentary Science Committee.

The idea of establishing a liaison body between Science and Parliament has found considerable support during recent years, and was particularly discussed at the recent British Association meetings held at Leicester. The idea has now taken shape, and at meetings of the British Science Guild and the Association of Scientific Workers, which were held in London last week, it was decided to form a Parliamentary Science Committee. Each of those two organisations is represented on the Committee, to which have been added representatives of other bodies concerned. The following scientific institutions and associations have promised their support :—The Institution of Mechanical Engineers, the Institution of Naval Architects, the Institute of Metals, the Institute of Physics, the Royal Institute of British Architects, the Society of Engineers, the Pharmaceutical Society of Great Britain, the Institution of Professional Civil Servants, the Joint Council of Qualified Opticians, the South-Eastern Union of Scientific Societies, and the Oil and Colour Chemists' Association. For the present the Committee is confining its attention to exploring and forwarding the subjects actually under preparation for Parliament by constitutional bodies. The Committee will meanwhile continue the periodical issues of "Science in Parliament," which is a summary of all parliamentary procedings affecting science collated from Hansard, and adequately indexed, from the opening of the 1932–33 session. The Chairman of the Executive Committee is Commander B. W. Bernacchi ; the Vice-chairman, Professor B. W. Holman ; and the joint hon. secretaries, Mr. A. Howard and Mr. W. J. Stone. The headquarters of the Committee are the British Science Guild, 6, John-street, Adelphi, W.C.2.

A New "Grid" Tariff.

Last week the grid tariff for the South-East England and East England areas was issued by the Central Electricity Board. It is well known that these tariffs for the various areas consist of a fixed kilowatt charge and a running charge, both subject to certain variations. In the former case the variations are governed by power factor and rates, and in the latter by the cost of fuel. With the object of stimulating the development of load, a progressive reduction of the kilowatt charge is made as the demand of an undertaking increases, in the manner described in our issue of December 2nd, 1932. The new tariff takes the usual form, and as regards service charge, fixed kilowatt charge in respect of each point of supply, and the variations of the fixed charge with power factor, it conforms in every respect with the previous tariff. Certain monetary values, however, apply to the new tariff alone. Engineers interested in these tariffs no longer need an explanation of all the details, and it will suffice to say with regard to the variation governed by rates that the fixed kilowatt charge is increased or reduced by the amount of 1s. 10d. for each shilling above or below 4s. 3d. as arrived at by the usual formula. For each kilowatt supplied and taken during the year the sum of 0·21d. is to be paid, and if the coal cost calculation gives a sum more or less than 16s., the running charge will be increased or reduced in the year by 0·0008d. for each penny by which the sum is above or below 16s. A halfpenny or any greater part is treated as one penny, whilst in the case of the rates variation of the fixed charge a *pro rata* increase or reduction is made for any part of one shilling. Trading operations, in accordance with the provisions of the Electricity Act, 1926, will begin under the tariff on January 1st, 1934.

Sheffield and Armaments.

An official statement with regard to the present activities connected with armament manufacture in Sheffield was issued by the Sheffield Chamber of Commerce on Monday last. The true facts, it states, are that during the last few years the normal programme of building in Great Britain has been cancelled and has not been reconsidered recently, in anticipation of a successful conclusion to the Disarmament Conference in Geneva. Replacement of ships and material, however, is greatly in arrears, and this accounts for the present slightly increased activity in many Sheffield concerns. Actually authentic figures show that not more than 20 per cent. of the turnover of the large steel firms is represented by armaments, and of this percentage a large proportion includes quantities of marine propelling machinery for warships being constructed under the ordinary programmes. With regard to the remaining 80 per cent. capacity this is represented by work in connection with large schemes for oil extraction from coal, the mercantile marine, alloy steels for motor cars, and stainless steel.

L.N.E.R. Development Schemes.

The London and North-Eastern Railway Company announced on Tuesday last that in consequence of the return of better trade conditions throughout its system, and in order to enable it to meet the possible requirements of a revival of industry, its directors had authorised a series of development programmes involving the expenditure of £2,300,000. Eighty new locomotives are to be constructed, nine of which will be of the 4–6–2 "Pacific" type at present used on the "Flying Scotsman" services. In addition, five 4–6–0 passenger locomotives of the "Sandringham" class for East Anglian services, twenty-five 4–4–0 passenger engines of the "Shire" class for the North-Eastern area, twelve 0–6–0 freight class, and ten 2–6–0 mixed traffic engines for the North-Eastern area are to be built. Five passenger locomotives of the 2–8–2 type are to be made for express services between Edinburgh and Aberdeen. Ten 2–6–2 tank engines for the North of England, and ten 4–4–4 tank engines are to be converted into a new 4–6–2 "Pacific" type tanks to assist the working of mineral traffic in the Durham district. Authority has also been given to proceed with the construction of fourteen locomotives, six of the 2–6–2 tank type for Scotland and eight 2–8–0 engines for East Anglia. The carriage and wagon programme includes sixty-two new carriages and 5579 wagons. The complete renewal of forty-three bridges and the renewal of 371 miles of track with the renovating of a number of stations will all be carried out during 1934.

The Late Mr. Hartley Grunwell.

We regret to have to record the death on Thursday, October 26th, of Mr. Hartley Grunwell, A.M. Inst. C.E., of Oakroyd-terrace, Manningham, Bradford, who for the past twenty-three years acted as inspecting engineer for the Port of London Authority. Mr. Grunwell was born at Farsley, and after attending the Fulneck Commercial School, was apprenticed to John Butler and Co. at Stanningley Ironworks, near Leeds. After a period of twenty years with the same firm, during which he became chief engineer of the mechanical department, and was entrusted with the carrying out of some of the largest contracts, Mr. Grunwell left for Glasgow, where he was appointed the assistant manager of James Goodwin and Co., a firm of bridge builders and general engineers. Six years later he took up a position on the executive engineering staff of the Glasgow Subway. In 1928 he joined S. Pearson and Co., Ltd., of Westminster, and was appointed Chief Mechanical Engineer on the Admiralty Harbour contract at Dover. For some time afterwards, he was at the company's Westminster office, after which he started his own business in Bradford as an inspecting mechanical and civil engineer.

New Dock at Belfast.

On Thursday, October 26th, the new dock and channel constructed by the Belfast Harbour Authority on the Antrim side of the harbour, was formally opened by the Duke of Abercorn, the Governor of Northern Ireland. The naming ceremony was gracefully performed by Princess Alice, Countess of Athlone, who named the channel the Herdman Channel, after Mr. R. E. Herdman, the present chairman of the Belfast Harbour Board, and the dock the Pollock Dock, after Mr. H. M. Pollock, the Minister of Finance and the former chairman of the Harbour Commissioners. The new works consist of a dock and turning basin on the site of the old timber ponds and a new channel, about a mile and a half in length, leading direct from the main Victoria Channel. The extent of the new dock is about 2600 linear feet—1020ft. with a depth of 30ft. at low water, and 1580ft. with a depth of 23ft. at low water. The Belfast Harbour now consists of three main channels—the centre Victoria Channel, with a number of docks running from it ; the Musgrave Channel, on the Co. Down side of the Lagan ; and the new channel and dock on the Co. Antrim side. As an indication of the traffic increase, it may be stated that the net tonnage which entered the port in 1921 was just over 5,000,000 tons, and in 1932 it was 7,500,000 tons. The goods imported in 1921 amounted to 2,250,000 tons, and in 1932 to over 3,000,000 tons.

"Grid" Electricity Schemes.

An official statement of the Central Electricity Board concerning the South-East England and East England schemes explains that, although the two area schemes were adopted and carried out as separate parts of the "grid" system, the Board has decided that for the purpose of trading they shall be treated as one. Electricity will be produced in the combined area in thirty-seven selected stations, including four new stations. Of the latter, Battersea is in the process of being put into commission, Fulham is under construction, and no decision has been taken regarding the other two. Among the principal stations are Barking, Deptford West, Brighton, Brimsdown, West Ham, Croydon, Stepney, Hackney, Bankside, and Norwich. Together with eighty-eight transforming and switching stations the power stations are interconnected by 1029 miles of transmission lines, of which 690 miles, including 15 miles of cable in the London area, are operated at 132 kV, and 399 miles, including 102 of cable, at lower voltages. Extensions to the north and west link up the area with the Mid-East England, Central England, and South-West England and South Wales scheme areas. The area to which the new tariff, referred to in another note on this page, will apply, extends to 12,266 square miles lying between the Wash and the South Coast, with the towns of Peterborough, Bedford, Reading, and Littlehampton, marking roughly the western boundary, and, including London, contains a population of approximately 13½ millions, or over 29 per cent. of the entire population of the United Kingdom. The total amount of electricity generated by authorised undertakings in the area last year was just over 4000 million units.

The Orient Line Fleet.

The managers of the Orient Line to Australia—Anderson Green and Co., Ltd., of Fenchurch-avenue, London—announced on Monday last that they had invited tenders for the construction of a new mail and passenger vessel for the company's Australian service. It may be recalled that the fleet now comprises five 20,000-ton liners of the "Orama" class, and two smaller tourist liners, the "Ormonde" and "Orsova." The 20,000-ton liners are propelled by geared turbine machinery with oil-fired boilers, and are noteworthy for their well-planned passenger accommodation. Speaking at Barrow-in-Furness on Saturday last, Commander C. W. Craven, the managing director of Vickers-Armstrongs, Ltd., referred to the Orient Line inquiry, and stated that it would be for a larger and better ship than the older ships which Vickers had constructed for the company.

Shipbuilding Rationalisation.

In the course of an address given by Mr. F. C. Pyman, of William Gray and Co., Ltd., West Hartlepool, to the West Hartlepool Rotary Club, on Monday, October 30th, some interesting figures regarding redundant shipbuilding capacity and the efforts made by National Shipbuilders' Security, Ltd., to meet the loss thus incurred were given. Ever since 1923, Mr. Pyman said, the industry had not been able to utilise more than half its capacity, and often in the last decade 25 to 30 per cent. was all that was needed, often nine out of ten berths being empty. The function of National Shipbuilders' Security, Ltd., was to offer a market for such yards at a price substantially above scrapping price, and to prevent yards falling into the hands of bargain hunters. The scheme had been in operation three years. In January, 1930, there were 684 berths, of which 43 had ceased to count, while a further 116 berths had been purchased, making a total reduction of 159, or, say, 25 per cent. Of the 684 berths, rather more than half were engaged in building cargo vessels, and that capacity had been cut down by 30 per cent. Less than one-quarter of the 684 were passenger liner or warship berths, and that capacity had been cut down by 7 per cent., while the remaining berths were normally engaged in the building of small craft. Efforts had been made to observe due apportionments between the various shipbuilding areas. The Clyde had so far sacrificed more than the North-East Coast, the percentages being 18·68 for the Clyde and 12·85 for the North-East Coast. The method of sterilising shipbuilding sites for forty years had been regarded as harsh, but what other method was available ? In any case, the company was making every effort to attract new industries to the demolished sites, and the present prospects of placing such sites were good. Mr. Pyman concluded by saying that if he had persuaded his hearers that the shipbuilders were tackling the problem wisely and courageously, and that the job might safely be left in their hands, then he was satisfied.

New Methods of Excavating Quicksands.*

By Sir HENRY JAPP, K.B.E., M. Inst. C.E., M. Soc. C.E. (France).

No. II.

(Concluded from page 402, October 27th.)

JOOSTEN CHEMICAL CONSOLIDATION PROCESS.

THE chemical consolidation process was discovered by Dr. H. Joosten in his work for Gebhardt and Konig, of Nordhausen, Germany, during his management of their potassium and salt mines. He found that the large accumulation of brine met with in seams and pockets during the excavation was a great source of danger, and by impregnating the ground with sodium silicate both the soil and the liquid were made into a hard mass by the combination of the sodium silicate with the brine. Patents were taken out for the application of this method in 1925 and 1926 as applied to the chemical solidification or petrification of loose soils.

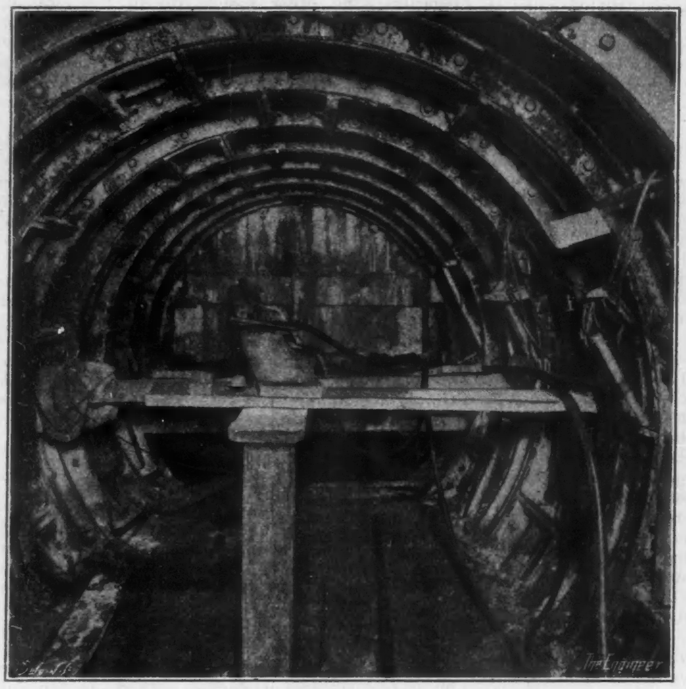


FIG. 18—MONUMENT STATION SEWER DIVERSION TUNNEL, CLOSE-BOARDED FACE

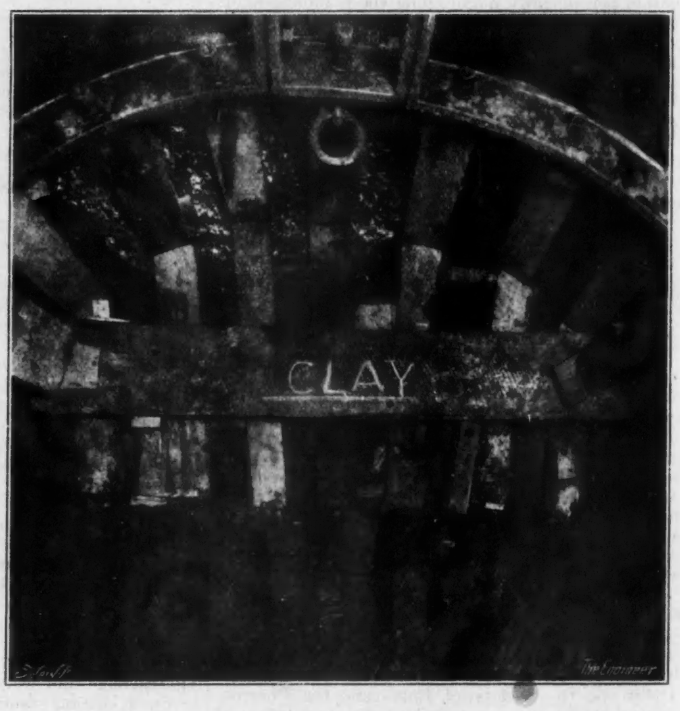
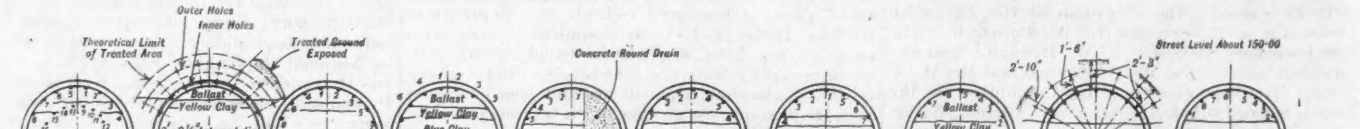


FIG. 20—SEWER DIVERSION TUNNEL AFTER CHEMICAL CONSOLIDATION

The great advantage of this process is that it is possible to transform loose sandy gravel in a shaft or tunnel heading into a permanent solid layer impervious to water. This method is, therefore, most useful for cutting off a flow of water where it is present, and making loose sand and gravel into a solid watertight material. The consolidation or petrification takes place at once, and requires no time for setting. As the chemicals are dissolved in water, forming a solution of one and a half times the specific gravity of water, they are able to penetrate wherever water may be, first driving the water before them without being diluted and then combining in a solid mass. This feature is an important one when compared with present methods of attempting to force fine cement grout into the minute interstices of sand or gravel. The cement is more likely to be filtered out and left to set in hard globular lumps without reaching the fine interstices and accomplishing its purpose. It is immaterial whether the sand is dry or under high water pressure, as the chemical consolidation process is adaptable to either condition. The process converts sand and ballast into a condition resembling a sandstone or conglomerate, and the impregnation can be carried on at almost any pressure to suit the head of water in the ground, pressures as high as 1400 lb. to the square inch having been recorded.

After determining on the location to be consolidated, injection pipes are driven into the mass by means of a compressed air hammer and special driving tools and connections; generally pipes of 1in. diameter of high-tensile steel, fitted with driving points and perforated near the point, are used. These pipes are driven a short distance at a time, when a measured quantity of Chemical No. 1 (sodium silicate) is pumped through the pipe; this is repeated after each short drive. When the pipe has been driven to the full depth required and Chemical No. 1 has been injected at each drive, a measured quantity of Chemical No. 2 (calcium chloride) is injected in the same way at each short withdrawal of the pipe. When the pipe is withdrawn it is found that the two chemicals have united on meeting and have formed a silica gel, together with the free silicic acid generated combining with the loose silicious particles forming the same binding material as in a natural silicious sandstone. This binds the ground treated into a solid permanent mass, which is insoluble in water. It is important to note that both chemicals combine to form one solid, so that no residual water is left in the ground likely to cause settlement and disturbance, as has been proved to be the case when cement slurries are used. Generally the pressures for injection vary from 50 lb. to 150 lb. per square inch. The effect is instantaneous, for as soon as the chemicals meet they combine and solidify or petrify the ground so that it is possible to remove the timbering immediately the last injection is completed.



Outer Holes
Inner Holes
Theoretical Limit of Treated Area
Treated Ground Exposed
Concrete Round Drain
Ballast
Yellow Clay
Blue Clay
8'-9½" Internal dia.
92
97 98
103
109
116
121
127
133
138
139
Axis 115·00
Street Level About 150·00
1'-6"
2'-10"
2'-3"
1 AA.
2 BB.
3 CC.
4 DD.
5 EE.
6 FF.
7 GG.
8 HH.
JJ.
9 KK.
16 Pipes 7 Inj. Each Started 31-3-32 (Day) Finished 13-4-32 (Night)
Section at Leading End of Ring 97, Showing Location of Holes at this Point. Also Treated Ground as Exposed when Excavating for Drain Connection.
8 Pipes 7 Inj. Each Started 21-4-32 (Night) Finished 22-4-32 (Day)
6 Pipes 7 Inj. Each Started 26-4-32 (Noon) Finished 27-4-32 (Noon)
5 Pipes 6 Inj. Each Started 6-30a.m. 30-4-32
7 Pipes 6 Inj. Each Started 5p.m. 5-5-32 Finished 5p.m. 6-5-32
7 Pipes 6 Inj. Each Started 10-5-32 (Noon) Finished 11-5-32 (Noon)
7 Pipes 6 Inj. Each Started 6-30p.m. 13-5-32, to Noon 14-5-32 (Sat.) Restarted 6·30a.m. 18-5-32 (Wed) Finished 6 p.m. 18-5-32
Cross Section Showing Results of Trial Holes Ahead of Ring 138. Consolidated Material 10" to 1' Above Position of Pipes at this Point.
8 Pipes 6 Inj. Each Except No. 7. 5 Only. Started 6·30a.m. 21-5-32 to 2 p.m. (Sat) 10·30 p.m. 22-5-32 (Sun) Finished 11 a.m. Mon 23-5-32
Ring 117, 2 Pipes 4 Injections Each
Leading Rings, & the Position of Pipes at the Face, at the Commencement of Each Length.
8 Pipes Driven from Ring 92
1 in 5½ Up
Trial Length
Concrete Sleeve
90
95
100
105
110
115
120
125
130
135
140
145
A
B
C
D
E
F
G
H
J
K
108·00
"THE ENGINEER"

FIG. 19—CHEMICAL PROCESS AS APPLIED TO SEWER DIVERSION TUNNEL

This process has also been found very useful in drying up brickwork or concrete walls, which under high water pressures may be leaking seriously. In such cases the water is forced back by pumping in the chemicals which, as stated before, go wherever water may travel, and the treatment reaches into the heart of the wall. This method is far superior to that of plastering or to cement grouting, as neither of these would be effective in the case of moderately wet or very wet walls. In plastering, a slight leakage of water may be stopped, but the effect is only on the surface, and affords very little resistance to pressure head. In cement grouting the cement is filtered out by the fine pores of the concrete or brickwork before it can penetrate into the body of the wall. In any event cement cannot be effective until the setting of the cement, so that when there is much leakage it is almost impossible to stop it by cement grouting.

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* Read before the British Section, Société des Ingenieurs Civils de France on Tuesday, 24th October, 1933.

In this chemical consolidation process the equipment required consists of several strong tanks in which the chemicals are mixed with water to the required specific gravity. A pump is required for each chemical; the pumps draw their supply of solution from the tanks and discharge into mains leading to the impregnating pipes. The equipment is of a simple nature, the chief expense being the supply of chemicals.

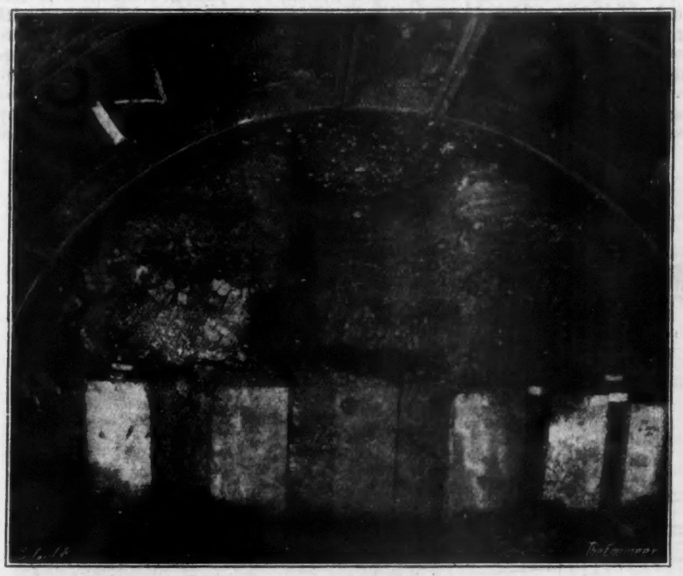


FIG. 21—SEWER DIVERSION TUNNEL AFTER CHEMICAL CONSOLIDATION

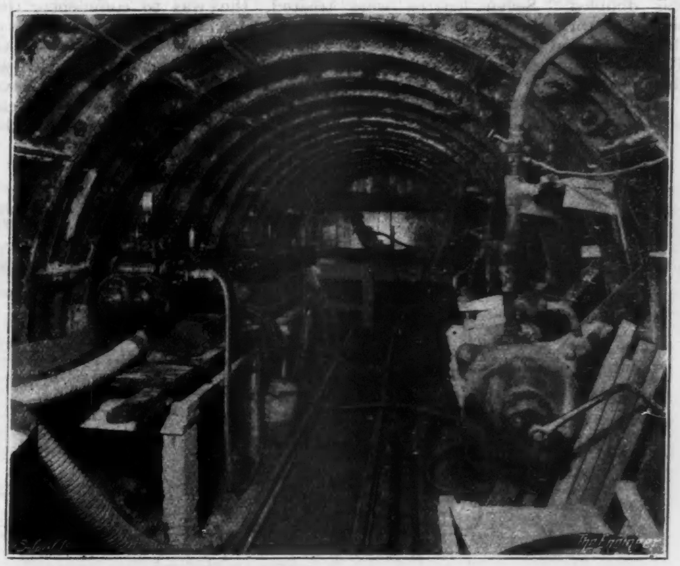


FIG. 22—PLANT AND PUMPS FOR CHEMICAL PROCESS

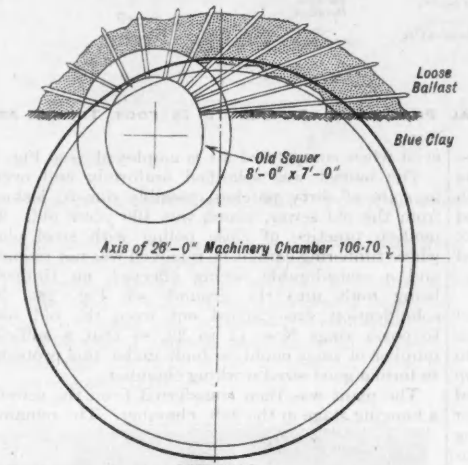
New applications of the process in engineering works are being developed continually, the process being proved invaluable in tunnelling unstable ground; in consolidating pile foundations which have been found to be settling, the carrying power has been greatly improved by solidifying the sandy soil around the base of the piles; retaining walls which have been in danger of collapse have had the ground behind them consolidated, resulting in safeguarding the structure; mine shafts have been made watertight, and the movement of abutments of bridges has been arrested. As time goes on it will be found that this system is a remedy which will become of more and more use to engineers.

The first application of this system in this country was in April, 1932, when John Mowlem and Co., Ltd., applied it to a trial length of the sewer diversion tunnel on the Bank–Monument Station contract, which they were carrying out for the Underground Electric Railways, under the direction of Messrs. Mott, Hay and Anderson, the consulting engineers in charge of the work. It was decided that a length of eleven rings, or 18ft. 4in., of the sewer diversion tunnel should be treated. The London blue clay was about 2ft. 6in. below the crown of the tunnel, and the ballast above the clay was of a very mixed and loose nature, requiring very careful and laborious tunnelling methods—see Fig. 18. This entailed close poling, packing with straw litter, pugging and grouting. Only very small widths could be exposed at a time, and, according to the modern practice, where polings have to be left in the ground behind the tunnel lining, steel instead of wooden polings were built in over each length of excavation. When an auger was drilled through the face boards, the sand and gravel were so loose that they poured through like an hour-glass; they had no cohesion and were practically dry. The original intention had been to put compressed air on this section, but it would have been impossible to hold the air, and as there was practically no water to be dealt with, no advantage was to be gained from it.

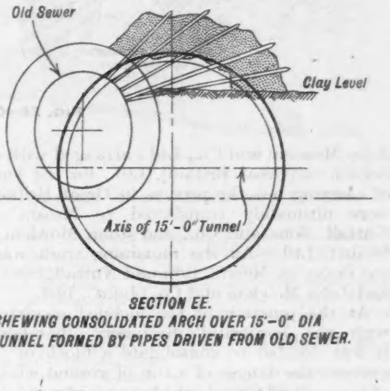
The scheme adopted on the trial length was to form an arch of chemically consolidated ballast about 2ft. thick over the crown of the tunnel. As shown on Fig. 19, this was carried out by driving injection pipes in the direction of tunnelling and radially from the axis of the tunnel. The pipes were passed through holes augered in the face boards at about 20in. centres, and were driven one at a time into the ballast by means of a compressed air hammer and special driving tools and connections. The pressures used for injection were from three to ten atmospheres. The estimated range of action was taken as being 1ft. around the pipes, which was proved in practice to be about right as a safe minimum. In order to cover eleven rings a second row of pipes was driven, as shown, inside the first row, which covered only six rings.

After treatment the ground was found to have been chemically solidified into a hard arch over the tunnel, and was also hardened in the face. It was possible to work with an open face, with occasional boards in the crown as a precaution and a relief to the dead weight of ballast above the solidified arch. These boards were removed as the rings were built so that no timbering was left in the ground—see Photographs 20 and 21. Trial holes were pricked in the consolidated arch, and the extent of the treatment was found to be from 12in. to 18in. above the line of the pipes.

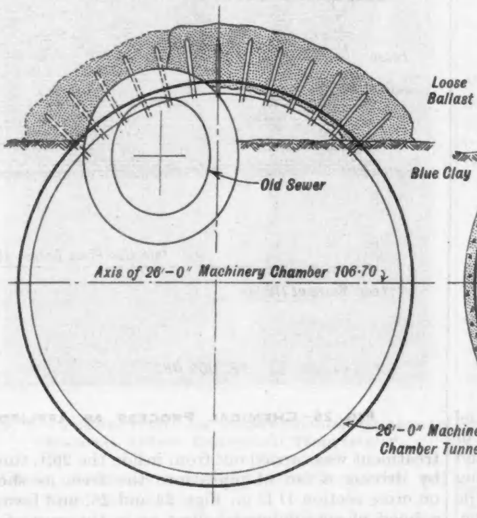
Where the gravel was originally loose and sand absent, the white substance (the resultant of the combination of the chemicals) appeared and filled the voids, and where the face was made up of well-graded ballast a hard conglomerate was formed, and the binding material was almost invisible. Beds of sand were found to be solidified into a form of synthetic sandstone, and the thin layers of clay and loam met with were found to have adhered to the consolidated ballast. The roof arch was very hard, and where it came within the digging line the conglomerate required breaking out with small air hammers. Although hard, it was possible to trim the underside of the arch of hardened ground evenly to the digging line. The ground below the arch, which had been solidified, could be broken out with a pick.



SECTION BB.
SHEWING PIPES DRIVEN FROM OLD SEWER FORMING CONSOLIDATED ARCH OVER 26′-0″ DIA TUNNEL.

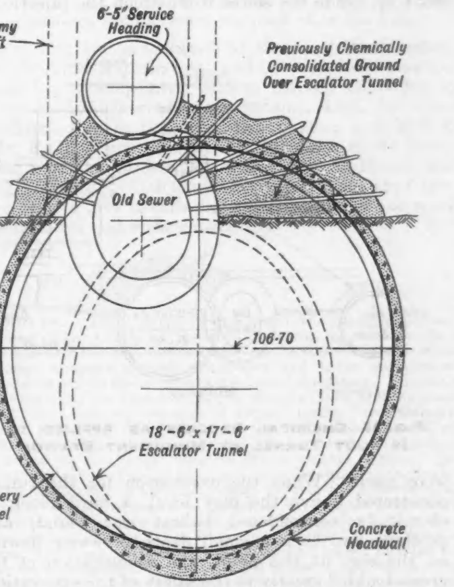


SECTION EE.
SHEWING CONSOLIDATED ARCH OVER 15′-0″ DIA TUNNEL FORMED BY PIPES DRIVEN FROM OLD SEWER.


Loose Ballast
Blue Clay
Old Sewer
Axis of 26′-0″ Machinery Chamber 106·70
26′-0″ Machinery Chamber Tunnel

SECTION DD.
SHEWING CONSOLIDATED ARCH FORMED OVER 26′-0″ TUNNEL BY PIPES DRIVEN FROM FACE OF 26′-0″

"THE ENGINEER"


Dummy Shaft
6′-5″ Service Heading
Previously Chemically Consolidated Ground Over Escalator Tunnel
Old Sewer
106·70
18′-6″ x 17′-6″ Escalator Tunnel
Concrete Headwall

SECTION CC.
SHEWING CONSOLIDATED ARCH FORMED OVER HEADWALL OF 26′-0″ IRON BY PIPES DRIVEN FROM OLD SEWER.

FIG. 23—CHEMICAL PROCESS AS APPLIED TO 26-FOOT TUNNEL AT MONUMENT STATION

As the treatment of the trial length of eleven rings proved satisfactory, an order was placed with Siemens-Schuckert (Great Britain), Ltd., to carry out treatment for the remaining forty rings of the sewer diversion tunnel. It was decided to drive one fan of pipes at a time for a sufficient distance to cover six rings, the chemical work being carried out by a specialist foreman, while the men in the tunnel face drove the pipes. It required twenty-four hours to treat a length of six rings, and excavation was commenced immediately the treatment was finished. One ring could be excavated and completed in one-third of the time taken in the untreated ground, and the general rate of progress of the tunnelling was doubled. Seven lengths were treated, the chemical work being commenced at whatever time the excavation of each six rings was completed. The plant and pumps required for this work are shown in Fig. 22.

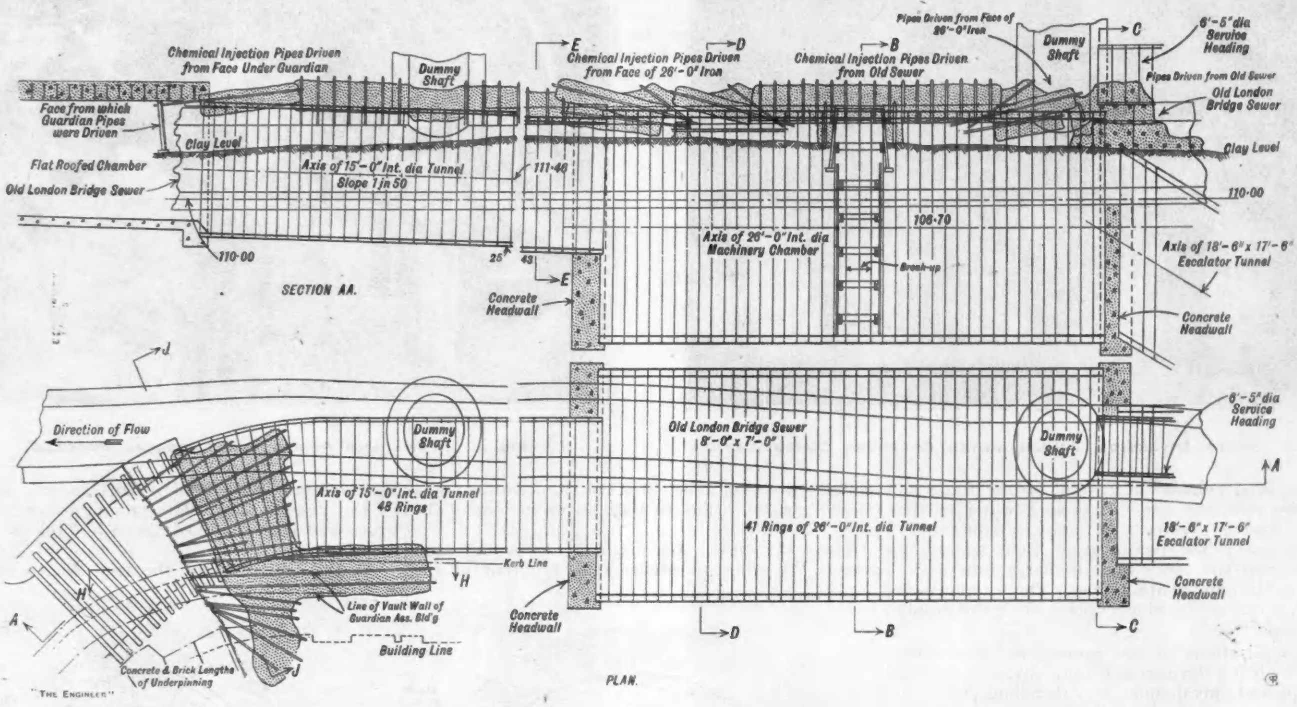

Chemical Injection Pipes Driven from Face Under Guardian
Dummy Shaft
E
D
Chemical Injection Pipes Driven from Face of 26'-0" Iron
B
Chemical Injection Pipes Driven from Old Sewer
Pipes Driven from Face of 26'-0" Iron
Dummy Shaft
C
6'-5" dia Service Heading
Pipes Driven from Old Sewer
Old London Bridge Sewer
Face from which Guardian Pipes were Driven
Clay Level
Flat Roofed Chamber
Old London Bridge Sewer
Axis of 15'-0" Int. dia Tunnel Slope 1 in 50
111·46
Clay Level
110·00
106·70
Axis of 26'-0" Int. dia Machinery Chamber
Break-up
Axis of 18'-6" x 17'-6" Escalator Tunnel
110·00
25
43
SECTION AA.
Concrete Headwall
Concrete Headwall
J
Direction of Flow
Dummy Shaft
Old London Bridge Sewer 8'-0" x 7'-0"
Dummy Shaft
6'-5" dia Service Heading
A
Axis of 15'-0" Int. dia Tunnel 48 Rings
41 Rings of 26'-0" Int. dia Tunnel
18'-6" x 17'-6" Escalator Tunnel
Kerb Line
H
H
Line of Vault Wall of Guardian Ass. Bld'g
Concrete Headwall
Concrete Headwall
A
Building Line
D
B
C
Concrete & Brick Lengths of Underpinning
J
"The Engineer"
PLAN.

FIG. 24—CHEMICAL PROCESS AS APPLIED TO 26-FOOT TUNNEL AT MONUMENT STATION

As the results of the application of the chemical process had proved so satisfactory, the contractors, John Mowlem and Co., Ltd., arranged with Siemens-Schuckert (Great Britain), Ltd., for the joint rights of carrying out the process in Great Britain, which were ultimately transferred to Messrs. Edmund Nuttall, Sons and Co., and John Mowlem and Co. (Joint), Ltd. All the remaining work was carried out direct by Messrs. Edmund Nuttall, Sons and Co., and John Mowlem and Co. (Joint), Ltd.

At the junction of the inclined escalator tunnel with the horizontal machinery chamber tunnel, it was decided to consolidate a block of ballast to prevent the danger of a run of ground when the top of the inclined tunnel, which was driven uphill, entered the ballast. Pipes were driven from the disused sewer in two layers at 1ft. 9in. centres, the pumps being fitted up inside the sewer from which the injections were made. When the excavation for the tunnel penetrated above the clay level, a hard block of chemically consolidated ballast was found, and as there had been a small depth of water flowing on the clay at this point, the solidification of the ground added greatly to the safety of the excavation, which would otherwise have been a delicate matter owing to the presence of water in the ballast.

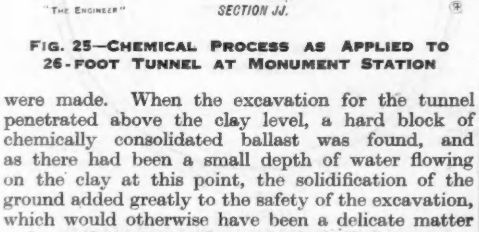

Roadway
Kerb 149·5
Made Ground
Loose Ballast
Ground Chemically Consolidated
Guardian Assurance Building Foundations
New Sewer
Old Sewer
15'-0" Int. dia Tunnel
Clay
110·00
"The Engineer"
SECTION JJ.

FIG. 25—CHEMICAL PROCESS AS APPLIED TO 26-FOOT TUNNEL AT MONUMENT STATION

For the chemical treatment of the 26ft. tunnel for the Monument Station, advantage was taken of the existence of the disused sewer for the first portion of the treatment. As shown on Fig. 23, a chemically consolidated arch was formed over the roof of this tunnel by driving pipes across the future tunnel and making two to three injections at the requisite distance of penetration. Pipes were driven one above the other in a vertical plane as shown. These "circles" of pipes were placed at 1ft. 9in. centres, and later widened to 2ft. centres. Careful supervision of the setting and driving of the pipes was needed to ensure that the solidification took place where required. Work was carried on day and night until a length of twelve rings from ring No. 18 to ring No. 29 had been treated. At each side of the break up for rings Nos. 20 to 21, where tunnelling was to commence, the ground was also solidified from the sewer to the digging line. Excavation was then commenced in the break up while chemical treatment proceeded as before to cover rings Nos. 17 to 11. This excavation was carried out boldly and rapidly, and open poling was used instead of the laborious methods necessary in loose ground, even when compressed air is employed—see Fig. 27.

The ballast was solidified uniformly and evenly in spite of dirty patches, possibly due to leakages from the old sewer, which was 100 years old. The modern practice of close poling with steel plates where timbering cannot be removed was not required, and a considerable saving effected, no timbering being built into the ground—see Fig. 28. The solidification was carried out from the old sewer to cover rings Nos. 11 to 29, so that a sufficient number of rings could be built under this protection to form a good-sized working chamber.

The plant was then transferred from the sewer to a hanging stage in the 26ft. chamber. The remaining treatment was carried out from inside the 26ft. tunnel by driving a fan of pipes into the face, as shown on cross section D D on Figs. 24 and 26, and forming a hood of consolidated ballast as in the case of the sewer diversion. Excavation proceeded in one face, while treatment was carried on at the other. When rings Nos. 16 to 12 had been built, excavation was carried on from rings Nos. 29 to 34, while the ground was treated from rings Nos. 11 to 5. This alternation was carried on until the tunnel and headwalls were completed. The final length of the headwall was treated from the old sewer, as the masonry of a dummy shaft of the old sewer, as shown on Fig. 25, interfered with treatment from the face. Tunnelling around this dummy shaft had to be carried out with caution, owing to the number of headings and passages already existing.

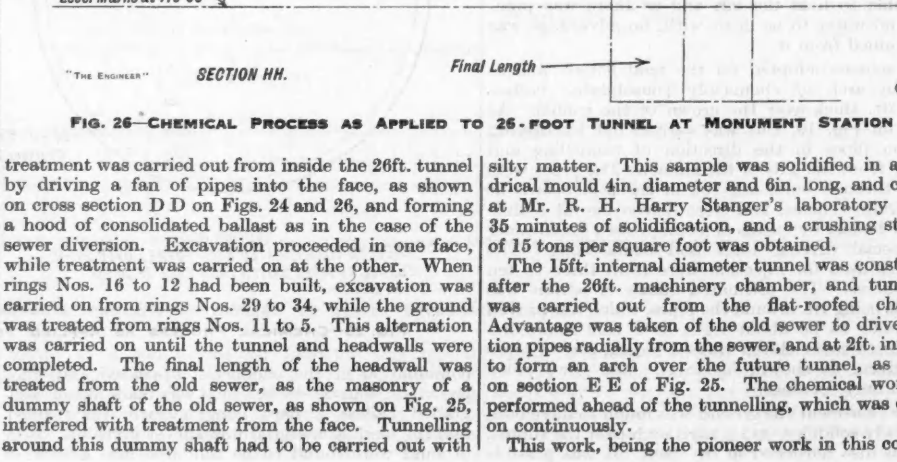

Guardian Assurance Building Foundations
Loose Ballast
Face from which Pipes were Driven
Clay Level
10
9
8
Lengths of Underpinning
Injection Pipes Driven 30'-0"
Level Marks at 110·00
"The Engineer"
SECTION HH.
Final Length

FIG. 26—CHEMICAL PROCESS AS APPLIED TO 26-FOOT TUNNEL AT MONUMENT STATION

As shown on Fig. 25, the concrete foundations of the Guardian Assurance building were 8ft. above the London clay, close up against the site of the 15ft. passage. The main length was done by ordinary underpinning, which became very costly, owing to the divergence of the 15ft. passage from the Guardian frontage. These foundations were underpinned with concrete and blue brickwork in the usual way, until a point was reached in which the line of the passage had diverged from the line of the foundations sufficiently far to make further underpinning unnecessary. In order to minimise the danger of any draw in the ballast when excavating for the cast iron lined tunnel, it was, however, decided that a protecting wall of consolidated ground should be formed along the frontage line. Fifteen pipes of 30ft. penetration were driven horizontally through the face boards and injected, while a return wall was formed at the end of the concrete underpinning by driving and injecting twenty-two pipes of about 12ft. penetration, working from the clay upwards. When excavation was carried out, the ballast, as shown in Fig. 30, was found to be chemically solidified from the clay tight up to the concrete, as no perceptible junction was visible between the concrete foundations and the solidified gravel. A sample of ballast from under the Guardian office contained 24 per cent. of dirt and silty matter. This sample was solidified in a cylindrical mould 4in. diameter and 6in. long, and crushed at Mr. R. H. Harry Stanger's laboratory within 35 minutes of solidification, and a crushing strength of 15 tons per square foot was obtained.

The 15ft. internal diameter tunnel was constructed after the 26ft. machinery chamber, and tunnelling was carried out from the flat-roofed chamber. Advantage was taken of the old sewer to drive injection pipes radially from the sewer, and at 2ft. intervals to form an arch over the future tunnel, as shown on section E E of Fig. 25. The chemical work was performed ahead of the tunnelling, which was carried on continuously.

This work, being the pioneer work in this country, has been described in somewhat minute detail, so that it may be clear how this interesting process can be employed in the most difficult situations.

Another interesting example of the use of this process in this country was carried out at Knightsbridge (East) Station, where Sir Harley H. Dalrymple-Hay, M. Inst. C.E., the consulting engineer for this work, employed the chemical process in the construction of the escalator tunnel, which was being constructed by Mitchell Brothers, Sons and Co., Ltd., for the Underground Electric Railways. The internal diameter of the cast iron lining of this tunnel was 23ft. 2½in., and there was only 2ft. 6in. of cover between the road surface and the top of the upper chamber.

The tunnel was to be driven at 30 deg. through yellow loamy sand with bands of clay into sand and small ballast with coarse ballast below, until London clay was reached, at a depth of 40ft. below the street. There was 8ft. of water lying on the clay, being considerably more than was found in the construction of the original station twenty-five years previously.

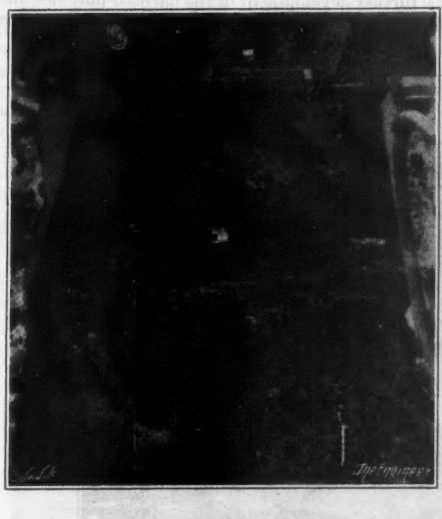


FIG. 27—EXCAVATION FOR BREAK-UP 26-FOOT TUNNEL AFTER CHEMICAL TREATMENT

Owing to the nature of the ground and the close proximity to buildings, roads and pipe services, the original scheme was to make use of a hooded shield and drive this tunnel under compressed air. However, after having had proof of the effectiveness of the chemical process, Sir Harley H. Dalrymple-Hay designed an alternative scheme of an original nature. This scheme is shown on Fig. 29, and consisted of first driving 4in. external diameter boring tubes into the clay at 1ft. centres over the crown of the future tunnel, and then driving injection pipes parallel to these and forming an arch of chemically consolidated ground around the 4in. diameter tubes The purpose of the 4in. tubes was two-fold. Firstly, they were to form a system of reinforcing bars in order to make perfectly sure that the weight of the ground would be safely carried by the chemical consolidation; and, secondly, in the event of any possible weak place these tubular bars could be used to support cross polings.

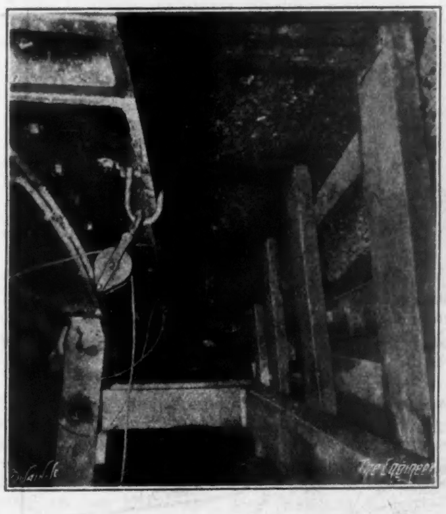


FIG. 28—EXCAVATION AFTER CHEMICAL INJECTION FOR LEADING RING OF 26-FOOT TUNNEL

Edmund Nuttall, Sons and Co. and John Mowlem and Co. (Joint), Ltd., carried out the chemical work and the boring from a 27ft. diameter semi-circular chamber, which was built above water level. The pipes were driven parallel to the 30 deg. tunnel, the maximum length of driving of any pipe being 40ft. In all, 1330ft. of the boring tubes were driven and augered out in three weeks by means of specially designed appliances. They proved to be perfectly true and straight for the whole length. The chemical pipes were then driven and treatment carried out in three more weeks, practically cutting off all water from the works.

Compressed air was then used as originally intended, and it was found that the amount of air required was greatly reduced, compared with the amount used for the small 8ft. pilot tunnel, and a very considerable saving in time and money compared with the shield method previously contemplated.

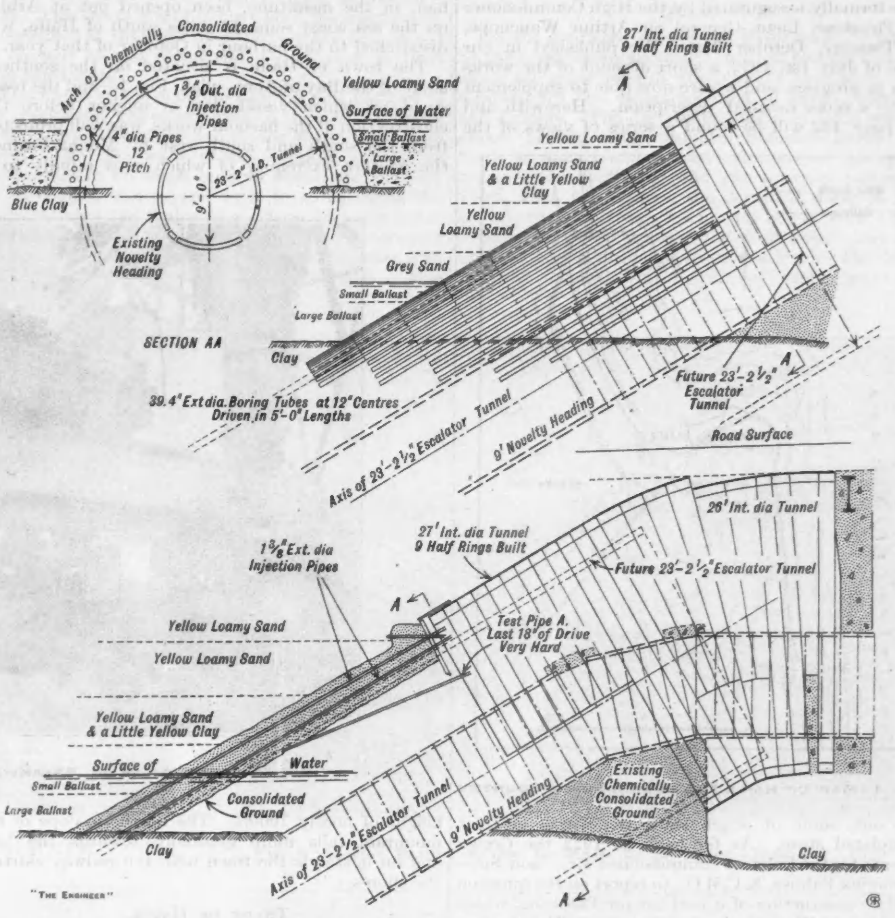

Arch of Chemically Consolidated Ground
1⅜" Out. dia Injection Pipes
4" dia Pipes 12" Pitch
Yellow Loamy Sand
Surface of Water
Small Ballast
Large Ballast
23'-2" I.D. Tunnel
9'-0"
Blue Clay
Existing Novelty Heading
27' Int. dia Tunnel 9 Half Rings Built
A
Yellow Loamy Sand
Yellow Loamy Sand & a Little Yellow Clay
Yellow Loamy Sand
Grey Sand
Small Ballast
Large Ballast
SECTION AA
Clay
39.4" Ext dia. Boring Tubes at 12" Centres Driven in 5'-0" Lengths
Axis of 23'-2½" Escalator Tunnel
9' Novelty Heading
Future 23'-2½" Escalator Tunnel
Road Surface
26' Int. dia Tunnel
27' Int. dia Tunnel 9 Half Rings Built
1⅜" Ext. dia Injection Pipes
Future 23'-2½" Escalator Tunnel
Test Pipe A. Last 18' of Drive Very Hard
Yellow Loamy Sand
Yellow Loamy Sand
Yellow Loamy Sand & a Little Yellow Clay
Surface of Water
Small Ballast
Large Ballast
Consolidated Ground
Existing Chemically Consolidated Ground
Axis of 23'-2½" Escalator Tunnel
9' Novelty Heading
Clay
Clay
"The Engineer"

FIG. 29—KNIGHTSBRIDGE EAST STATION, CONSOLIDATED GROUND OVER ESCALATOR TUNNEL

The loamy sand was found to have been successfully hardened in spite of the presence of bands of yellow clay, while the ballast was consolidated up to the pilot tunnel, and was very successfully treated, although this was done in 8ft. of standing water at the end of a 40ft. drive of pipe.

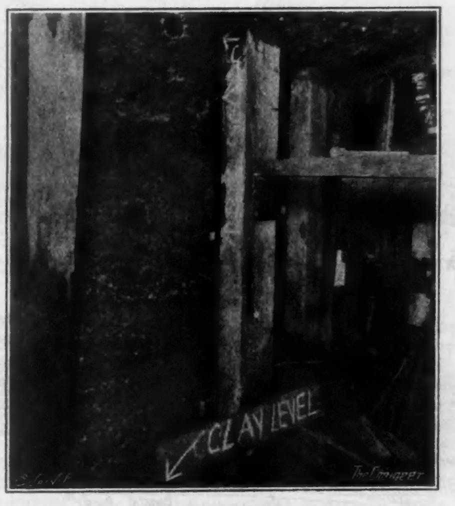


FIG. 30—EXCAVATION FOR UNDERPINNING GUARDIAN BUILDING AFTER CHEMICAL TREATMENT

Other chemically consolidated works carried out in this country include:—

Stoppage of leaks in concrete walls at the Ford Motor Company's power-house at Dagenham. Consulting engineer, Sir Cyril Kirkpatrick and Partners.

Consolidation of ballast in 8ft. of water in order to support the weight of the proposed shield at Knightsbridge (East) Station. Consulting engineer, Sir Harley H. Dalrymple-Hay, M. Inst. C.E.

Chemical injection behind clutches of "Simplex" steel sheet-piled dam to prevent water leakage at Knightsbridge (West) Station. Consulting engineer, Sir Harley H. Dalrymple-Hay, M. Inst. C.E.

Consolidation of ballast over 22ft. 9in. escalator tunnel for John Cochrane and Sons, Ltd., at Chancery-lane Station to make the ground secure and prevent air loss. Consulting Engineers, Messrs. Mott, Hay and Anderson.

Underpinning to a party wall at the new R.I.B.A. Building, Portland-place, by consolidating the ballast from the footings to the London clay through 7ft. of water. Consulting engineers, Messrs. R. T. James and Partners.

Many applications of this chemical process have been made on the Continent, and the following give an idea of the range of applications:—

For supporting the ground at the end of existing bridge piers during widening of the Jannowitz Bridge, Berlin.

Forming a wall of solidified sand from 60ft. to 90ft. below ground level to protect the existing piers of the Monbijou Bridge while a caisson was being sunk close to it, and 30ft. deeper at the University Eye Hospital, Berlin.

For closing the end of a trench sheeted with steel piling. Large pipes passing through the end of the trench prevented closing by steel piles, and the ballast was solidified round the pipes, at the Ankelmannplatz, Hamburg.

For prevention of leakage through the walls of graving docks at Kiel and Wilhelmshaven.

For prevention of leakage in dams and weir walls at Yngeredsfors, Sweden, and Grodek, in Poland.

For solidifying the ground between a timbered excavation and existing buildings. The buildings were settling owing to loss of ground during excavation. A row of pipes were driven and injected between the side of the pit and the buildings, and movement was arrested, in Hamburg.

The author is indebted to Mr. H. J. B. Harding, of Edmund Nuttall, Sons and Co. and John Mowlem and Co. (Joint), Ltd., and to Mr. H. C. Wehe, of Siemens-Schuckert (Great Britain), Ltd., for their collaboration in preparing this paper; and also to Mr. F. E. Wentworth-Sheilds, Sir John Wolfe Barry and Partners, Messrs. Mott, Hay and Anderson, and Sir Harley H. Dalrymple-Hay, for their kind permission to give details and photographs of the work being done under their direction.

THE CHARTERED INSTITUTE OF PATENT AGENTS.—The annual dinner of the Chartered Institute of Patent Agents took place on Tuesday evening, October 31st, at the Hotel Victoria, when a large company of members, guests, and ladies was present and took part in the dance which followed the dinner. The chair was taken by the President, Mr. G. Melville Clark, and the toast of "The Chartered Institute of Patent Agents" was fittingly proposed by Dr. M. F. Lindley, the Comptroller-General of Patents, Designs and Trade Marks. In his speech, Dr. Lindley referred to the happy relations which existed between the Institute and the Patent Office, and called attention to the forthcoming meetings in London in May, 1935, of the International Union for the Protection of Industrial Property, which would consider the international sides of the question. The new Designs and Patents Act had been in operation for close upon a year, with very satisfactory results, and he looked forward to the early completion of the work for a new Trade Marks Act. The President briefly responded to this toast. In proposing the toast of "Our Guests," Mr. C. E. Every-Clayton referred to the excellent work which Sir William Jarratt, late Comptroller-General, was doing as Secretary of the Patents and Designs Federation, and he also complimented Mr. Justice Sir Fairfax Luxmore on his work on the Patent Appeal Tribunal. In responding to this toast Sir Fairfax Luxmore spoke of the help given to him by the members of the Institute. In supporting the toast, Mr. Alan E. L. Chorlton, President of the Institution of Mechanical Engineers, stressed the importance in national life of the engineer and the value to industry of invention. He said that he was sure that the Institute always did and would always do its best to help the engineer inventor, and he referred to the efforts towards that end which were being made by a committee of the Institution of Mechanical Engineers.

Haifa Harbour.

THE harbour works at Haifa on the coast of Palestine, the construction of which was begun in 1929 by the Government of the Mandated Territory, were formally inaugurated by the High Commissioner for Palestine, Lieut.-General Sir Arthur Wauchope, on Tuesday, October 31st. We published in our issue of July 1st, 1932. a short account of the works then in progress, and we are now able to supplement it by a more detailed description. Herewith and on page 432 will be found a series of views of the harbour, some of which show the works in their completed state. As far back as 1922 the Crown Agents for the Colonies commissioned Mr.—now Sir—Frederick Palmer, K.C.M.G., to report on the question of the construction of a harbour for Palestine, which has a coast line of about 150 miles. The surveys and investigations made under his direction definitely indicated Haifa as the most suitable site for a harbour in preference to any other of the sites that had been suggested, including Jaffa. Mr. Palmer's report was made in 1923, but it was not until June, 1927, that his recommendations to construct a harbour at Haifa, at an estimated cost of £1,000,000, was adopted, and Messrs. Rendel, Palmer and Tritton were appointed consulting engineers for the work. The plans prepared, after a detailed survey of the site and borings had been made, included works estimated to cost 1½ million pounds. In February, 1929, it was decided to construct the harbour works by direct administration under the supervision of the engineers, and the Haifa Harbour Works Department was organised for that purpose. Preliminary work was begun in April, 1929, and the first train load of stone from the quarries, which had, in the meantime, been opened out at Athlit, on the sea coast some 10 miles south of Haifa, was dispatched to the harbour in October of that year.

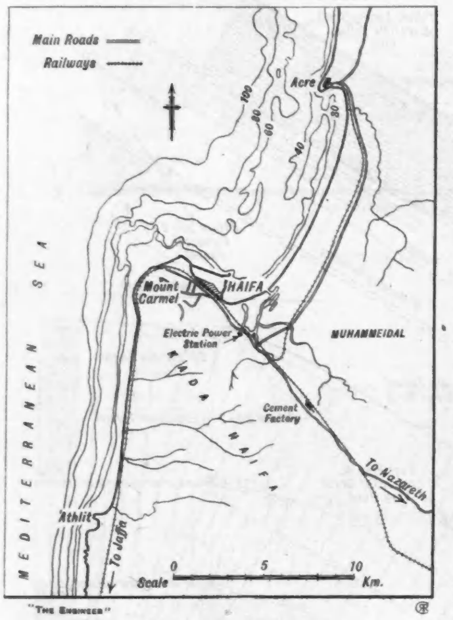

Main Roads
Railways
Acre
100
80
0
30
MEDITERRANEAN SEA
Mount Carmel
HAIFA
Electric Power Station
MUHAMMEIDAL
PLAIN OF HAIFA
Cement Factory
To Nazareth
Athlit
To Jaffa
Scale
0
5
10
Km.
"The Engineer"

FIG. 1—MAP OF HAIFA AND SURROUNDING COUNTRY

The town of Haifa is situated on the southern shore of the Bay of Acre—plan, Fig. 1—and the roadstead, in which vessels lay at anchor before the construction of the harbour works, was well protected from the south and south-west by Mount Carmel, the western extremity of which rises rapidly to a height of nearly 1000ft. The northern slope of the mountain falls more gradually towards the bay, and on it stands the town with the railway skirting the shores.

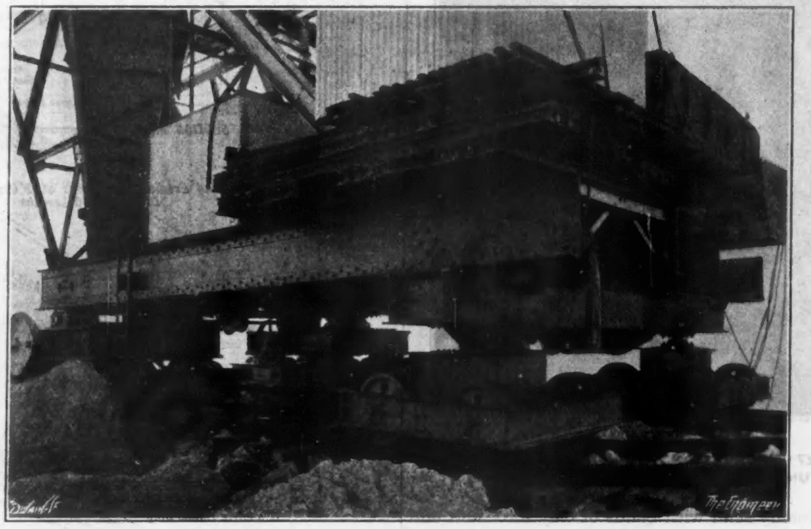


FIG. 3—CRANE ON MAIN BREAKWATER AFTER STORM OF JANUARY, 1931

TRADE OF HAIFA.

Haifa is the only harbour on the Palestinian coast, and in the past the absence of harbour facilities has been one of the hindrances to the development of the shipping trade of the country. At Jaffa, which, from the days before the rise of the Roman Empire, has been regarded as the port of Jerusalem, vessels still have to lie in the open roadstead, and both goods and passengers are conveyed to and from the shore in lighters and boats. Haifa is the headquarters of the Palestine Railways, and, since the British mandate, has developed into a busy industrial town. The terminal at Haifa of one branch of the Iraq oil pipe line is now assured, and is expected to have a capacity of 2,000,000 tons annually. A site for an oil dock was provided for when designing the harbour, at the south-east end under the shelter of the lee breakwater, and work on it and on the east reclamation, which will be made concurrently with the oil dock, has begun. A concession for the abstraction of salts from the Dead Sea is now being developed, mainly with capital from Jewish sources, and an annual export through Haifa of 100,000 tons of potash is expected. The fruit trade of Palestine is growing rapidly, the Jaffa orange being one of the principal exports of the country at the present time. Estimates based on the acreage of orange groves, which have or are being planted, show a possible development from the present maximum annual export from Palestine of four million cases to over nine million cases within ten years. The major part of this increase might have to be dealt with at Haifa, and, should such estimates be realised, some further development of the harbour may become necessary within a short time. Provision has been made for the development of the western part of the harbour within the breakwaters by the construction of additional quayage, as shown on the plan—Fig. 2.

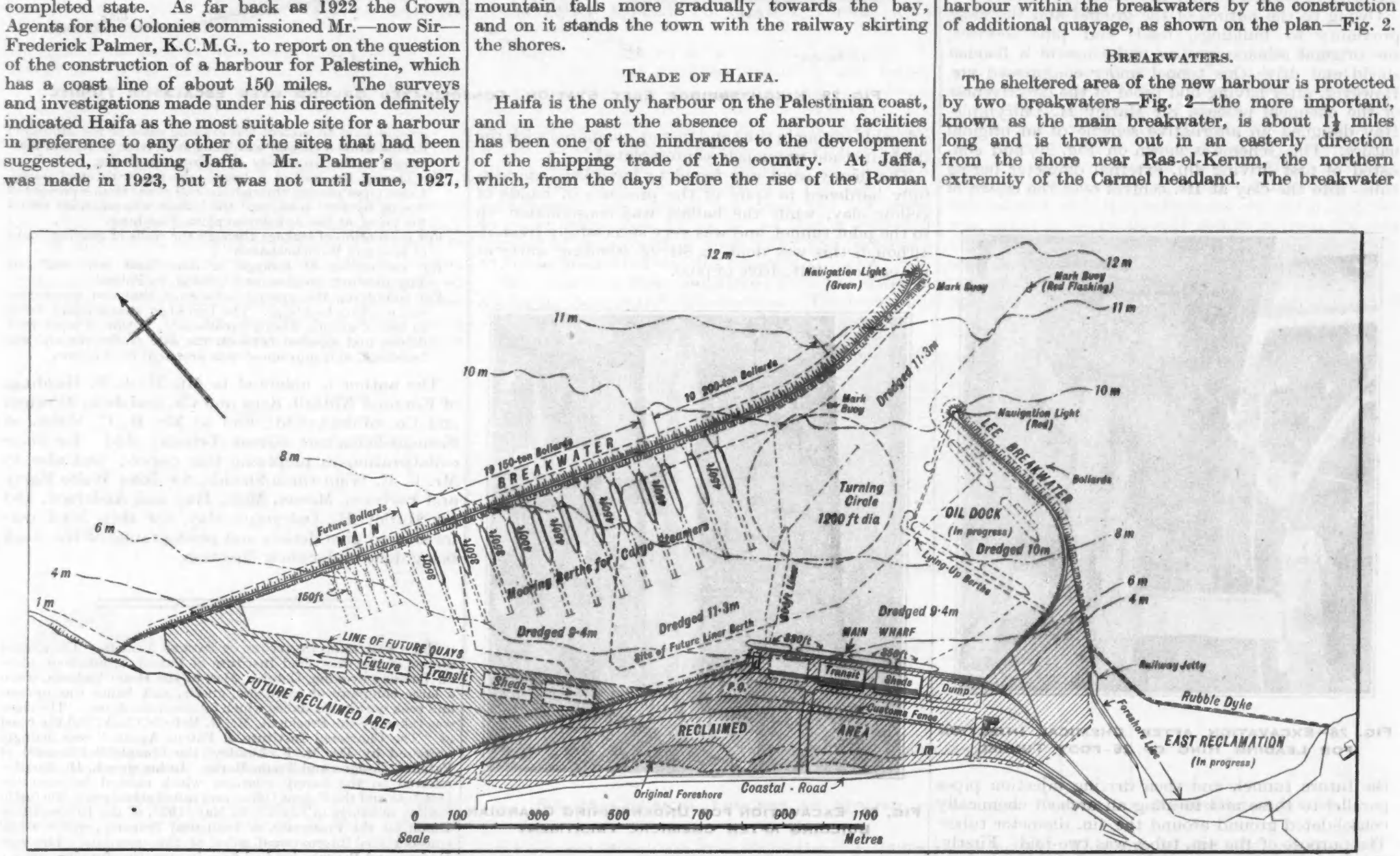

12 m
12 m
11 m
11 m
10 m
10 m
8 m
8 m
6 m
6 m
4 m
4 m
1 m
1 m
Navigation Light (Green)
Mark Buoy
Mark Buoy (Red Flashing)
10 200-ton Bollards
Mark Buoy
Dredged 11·3m
Navigation Light (Red)
LEE BREAKWATER
Bollards
19 150-ton Bollards
MAIN BREAKWATER
Future Bollards
350ft
350ft
350ft
400ft
450ft
400ft
450ft
400ft
450ft
160ft
Mooring Berths for Cargo Steamers
Turning Circle 1200 ft dia
OIL DOCK (In progress)
Dredged 10m
Lying-Up Berths
Dredged 9·4m
Dredged 11·3m
Dredged 9·4m
Site of Future Liner Berth
MAIN WHARF
880ft
860ft
LINE OF FUTURE QUAYS
Future Transit Sheds
Transit Sheds
P.O.
Dump
Customs Fence
Railway Jetty
Rubble Dyke
Foreshore Line
FUTURE RECLAIMED AREA
RECLAIMED AREA
EAST RECLAMATION (In progress)
Original Foreshore
Coastal - Road
0
100
300
500
700
900
1100
Scale
Metres
"The Engineer"

FIG. 2—PLAN OF HAIFA HARBOUR, 1933

BREAKWATERS.

The sheltered area of the new harbour is protected by two breakwaters—Fig. 2—the more important, known as the main breakwater, is about 1¼ miles long and is thrown out in an easterly direction from the shore near Ras-el-Kerum, the northern extremity of the Carmel headland. The breakwater is roughly parallel with the town frontage. The second, or lee breakwater, forms a seaward prolongation of the previously existing railway jetty at the east end of the town. It is about half a mile long and runs out in a northerly direction. The tidal rise at Haifa is insignificant, rarely exceeding 1ft., with a maximum range of about 3ft. The maximum exposure of the works is from about north-west on a line oblique to the face of the main breakwater. The lee breakwater and the inner works of the harbour are, therefore, well sheltered from storms. The sea bed over the harbour area is for the most part compact firm sand, forming an excellent foundation for the rubble mounds which constitute the breakwater and the rubble base for the quay walls.

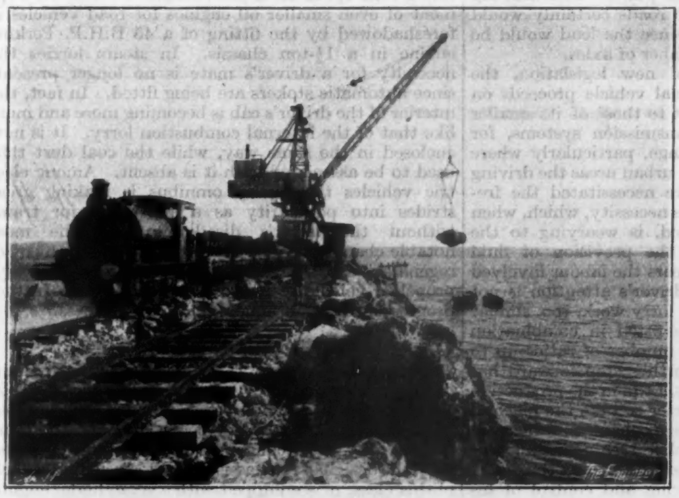


FIG. 4—MAIN BREAKWATER AND CRANE—JANUARY, 1931

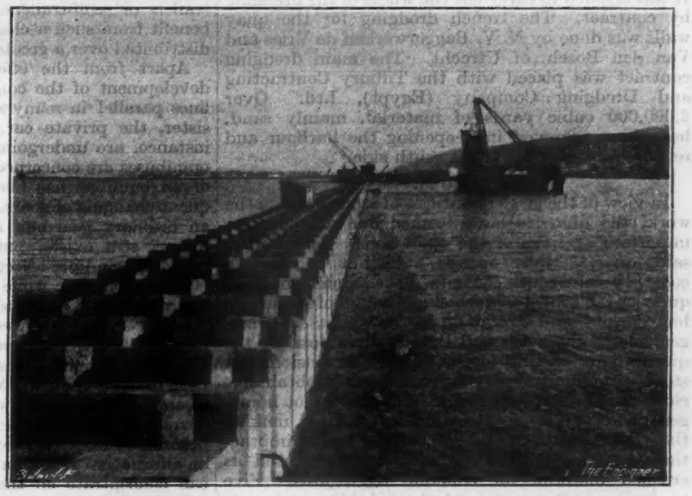


FIG. 5—SLICED BLOCK WORK IN MAIN QUAY WALL—JANUARY, 1932

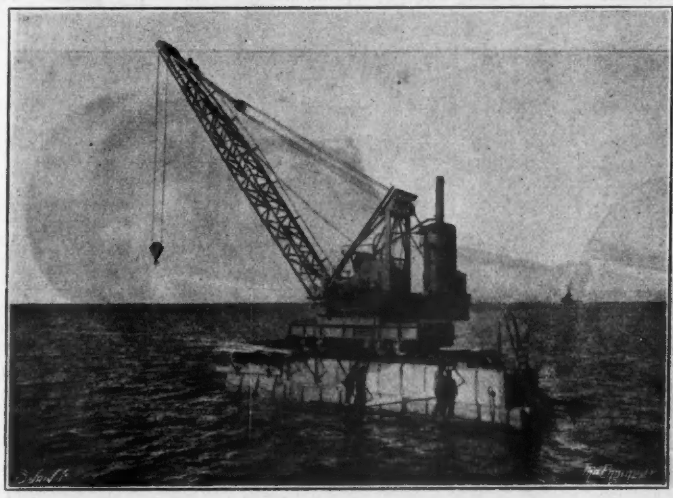


FIG. 6—MAIN QUAY WALL AND BLOCK-SETTING CRANE—SEPTEMBER, 1931

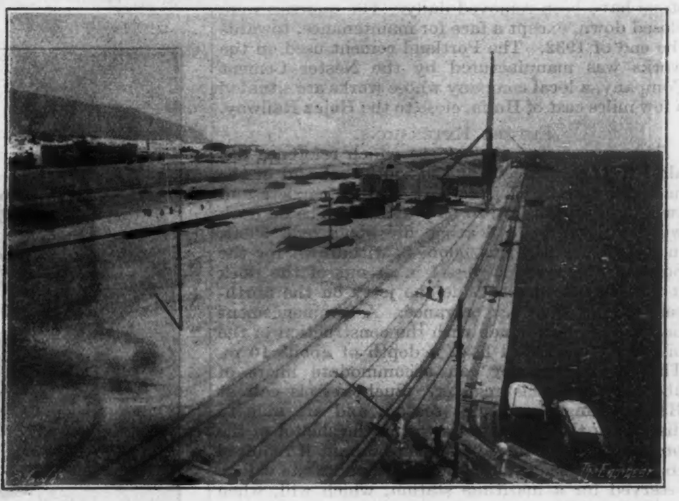


FIG. 7—DEEP-WATER QUAY AND RECLAIMED AREA—AUGUST, 1933

MAIN BREAKWATER.

The main breakwater constitutes the largest item of cost in the works; it is formed of natural blocks of quarried stone, graded according to size, the larger stones up to 15 tons weight being placed on the seaward face. The core or hearting material of the breakwater is of small stones from the quarries ranging in size from a few pounds each up to 1 cwt. The structure has a width of about 23 m. at mean sea level, and the upper part of the rubble mound has a slope on the sea face of 1 in 4. The settlement of the rubble in the sand of the sea bed has, it is believed, been relatively small. The head of the breakwater is situated close to the 12 m. contour and the average depth of water on the site of the breakwater mound is between 8 m. and 9 m. Throughout its entire length the breakwater is constructed with a concrete capping and parapet laid *in situ*, the top of the parapet being 4 m. above datum (mean sea level at Haifa). Views of the concrete work are shown in Figs. 8 and 9, page 432; both show the breakwater looking towards the inner or west end. At intervals of about 33 m. along the middle portion of the breakwater are set heavy cast steel mooring bollards—see plan, Fig. 2—one of which is seen in Fig. 8. These are bedded in masses of concrete keyed into the rubble mound. Some of these bollards are designed to take a pull of 200 tons and others of 150 tons. The mooring system adopted at Haifa provides for stem-on mooring of ships to the breakwater bollards, vessels dropping their head anchors when berthing. The general arrangement of the moorings is indicated in the plan —Fig. 2. The main breakwater contains about 1,100,000 cubic yards of stone rubble; the maximum quantity deposited in one month being 69,000 cubic yards. The stone, all of which came from Athlit, is a sandstone of medium hardness, which is capable of being quarried in large masses. All of it was hauled from Athlit over the Palestine Railways. Some of the stone of the smaller grades, forming the core of the breakwater mound, was deposited from hopper barges up to a level which would permit of discharge by this means. The remainder was placed in position by a specially designed pillar crane —Figs. 3 and 4—capable of handling a load of 15 tons at a radius of 65ft. All but the largest stones were tipped from steel tray skips (seen in Fig. 4). The crane ran on two 4ft. 8½in. gauge tracks connected to the service tracks for the trains of stone trucks. All the tipping in advance of the formation level was done "end-on" by the crane, no staging being used. The crane was supported on six bogie trucks very fully articulated to provide for inequalities of level in the rail tracks. The details of the crane carriage can be seen in the view, Fig. 3, showing the bogies and twisted rails after a very heavy storm in January, 1931. This storm is said to have been the most severe experienced at Haifa for over thirty years, but caused no damage to the permanent works, even in their unfinished state.

The whole of the concrete capping and parapet of the breakwater was constructed on the return journey of the temporary crane and as the wagon rails were lifted. The side walls of the capping serving as shuttering are of rough random sandstone masonry set in cement mortar and built in so as to fill the voids between the underlying masses of large stone. Timber shuttering was used only for the concrete coping. The stunt ends of sections of the mass concrete were also built up of rough masonry. This method of construction was found to be both more suitable and more economical than fitted forms. The concrete was gauged and mixed on a lighter, seen in Fig. 9, moored alongside the breakwater, the mixed concrete being placed in position in the breakwater by a transporter, also mounted on the lighter. The cement, aggregates, and water were brought to this floating concrete plant from the shore by supply lighters. The concrete aggregates used were crushed limestone from a privately owned quarry in Mount Carmel, and sand from the foreshore at Athlit.

LEE BREAKWATER.

The lee breakwater, which, as we have already said, is formed by prolonging the old railway jetty, contains about 230,000 cubic yards of stone. It is of less massive section than the main breakwater, its top width being only 5 m. The outer slope of the mound is 2 in 3 and the harbour slope 3 in 4. The commencement of the construction of the lee breakwater was retarded in order that it should have the protection of the main breakwater during the winter storms. Two views of the completed breakwater are shown in Figs. 10 and 11. The first, a view looking north, shows the main breakwater in the distance, and the second, looking to the south, the breakwater head and light. The lee breakwater was provided with bollards, similar to those on the main breakwater, for temporary use as "stem-on" moorings, pending the decision, now taken, to construct the oil dock under its shelter. The method of construction adopted for the lee breakwater was the same as for the main breakwater and the plant employed was of similar character, except that the crane used on the former was of 12 tons capacity and the stone rubble used in facing the slopes is in general of smaller dimensions than in the main structure.

QUAYS.

On the landward side of the water space enclosed by the breakwaters an area of land has been reclaimed, along the outer edge of which quays have been constructed for the accommodation of cargo steamers and lighters. The deep-water quay, or main wharf, about 1400ft. long, provides accommodation for three or four steamers. An extension of this quay towards the south-east and east provides quayage, 800ft. long, for lighters, the depth of water in the berths varying from 9·4 m. to about 5 m. The steamer berths in front of the deep-water quay are dredged to 9·4 m. below mean sea level. The quay walls are constructed of concrete blocks, generally 5 to 7 tons in weight, capped with mass concrete. For the most part the block work has been set on the slicework principle, and a view of the main quay, in course of construction, is shown in Fig. 5. The block work is founded at a level of 10 m. below mean sea level on a rubble base, which has a minimum thickness of 1 m. The rubble base was deposited from hopper barges in a trench dredged in the sea bed, consisting of sand, clay, and some conglomerate. The construction of the quay walls was begun at a central abutment of horizontal coursed blocks, from which the sliced work was continued in both directions by two 8-ton cranes travelling on the wall itself. A view of the central abutment and the first crane in course of erection is reproduced in Fig. 6. Horizontal block work was also employed for the western terminal of the quay wall and at the angle in the lighter quay. All the quay walls are backed by stone rubble placed in position before the sand filling was deposited.

RECLAMATION.

Where the reclaimed area is not bounded on the harbour side by quay walls, it is retained by rubble stone dykes. Both the western and the eastern dykes have been completed (see plan, Fig. 2), and about 90,000 cubic yards of stone was used in their construction. The material for the reclamation has been dredged from the deep-water area formed between the breakwaters, the land so reclaimed being about 91 acres. The sand filling was pumped ashore at suitable points or on the quay walls and dykes, and is forming an excellent and firm foundation for roads and buildings.

TRANSIT SHEDS, &c.

Two single-storey steel-framed transit sheds, supported on piled foundations, have been built behind the deep-water quay. One is so constructed as to permit of the addition of a second storey if this should be found necessary for the orange traffic. The walls of the transit sheds, as well as some of the other buildings erected in connection with the harbour, are constructed of Winget concrete blocks made on the site. The doors of the sheds, are steel-framed, filled in with reinforced concrete panels. The general arrangement of the road and railway facilities on the quays and reclaimed area will be clear by reference to the plan, Fig. 2; and a view of the deep-water quay is reproduced in Fig. 7.

DREDGING.

In the initial stage of the harbour development, now completed, about 175 acres have been dredged; about 100 acres to a depth of 11·3 m. below mean sea level, and the balance to 9·4 m. or over. It was decided to carry out the whole of the dredging by contract. The trench dredging for the quay walls was done by N. V. Baggerwerken de Vries and Van den Bosch, of Utrecht. The main dredging contract was placed with the Tilbury Contracting and Dredging Company (Egypt), Ltd. Over 2,000,000 cubic yards of material, mainly sand, have been removed in deepening the harbour and reclaiming the areas on its south side.

QUARRIES.

In view of the large quantities of stone used on the work, the quarries have formed one of the most important sections of the operations. As we have said, quarries were opened at Athlit on the sea coast, 10 miles south of Haifa. The stone from these quarries is a sandstone, which, although of somewhat low density and not of great hardness, is homogeneous in character and thus renders possible the quarrying of natural blocks of large dimensions. A stone of greater density and hardness is obtainable close to the site of the works, but this is not homogeneous, and is laminated and much fissured, making the quarrying of blocks of sufficient size impracticable. This hard stone was, however, used as crushed material for concrete aggregates. Five quarrying units were worked at Athlit, each unit comprising one 15-ton derrick crane and two 5-ton travelling cranes. Quantities up to 5000 tons of stone have been removed daily. The quarries were closed down, except a face for maintenance, towards the end of 1932. The Portland cement used on the works was manufactured by the Nester Cement Company, a local company whose works are situated a few miles east of Haifa, close to the Hejaz Railway.

FUTURE EXTENSIONS.

The site of the oil dock, to which reference has already been made, is at the south-east end of the harbour. Berthing jetties for two oil carriers and two lay-by berths are to be provided. The oil dock will be closed by a floating fire boom over 300ft. in length. When this boom is withdrawn for the purpose of passing a vessel in or out of the dock it will be placed alongside the jetty on the north-east side of the dock entrance. A commencement has already been made with the construction of the oil dock, which will have a depth of about 10 m. The harbour proper can accommodate liners of about 30,000 tons register. Such vessels call at Haifa during the tourist season, and are able to disembark their passengers within the shelter of the breakwaters. A liner berth can be built if required to enable passengers to land direct, and a site will be reserved for a maritime station, which will, when built, in addition to serving local requirements, act as the terminal for the proposed Haifa–Baghdad Railway, should the latter be constructed.

The area of sheltered water inside the breakwaters is approximately 300 acres, but will be reduced to about 250 acres when the reclamation at the western end of the harbour and the future extensions of quays have been carried out. The plan, Fig. 2, shows the position of the future line of quays and transit sheds. The total expenditure on the harbour works of about 1¼ millions includes all the works which are shown in the plan of the harbour, with the exception of the future reclamation; the oil dock and its accessories, and the east reclamation now in progress. The post office, general office, and Customs house, which, except for the foundations, were built under the direction of the Palestine Public Works Department, are covered by the expenditure of 1¼ millions.

We are indebted to Messrs. Rendel, Palmer and Tritton for the use of plans and photographs and for information which has enabled us to prepare this description of the harbour works.

MANCHESTER ASSOCIATION OF ENGINEERS.—At the opening meeting of the session the Constantine Medal for the best paper read during the preceding session was awarded to Mr. S. N. Brayshaw, M.I. Mech. E., for his contribution on "The Design and Operation of Industrial Furnaces." The Butterworth Medal for the best contribution to the discussions was awarded to Mr. C. H. Painer.

Commercial Motor Transport Exhibition.

No. I.

THERE are definite indications at the Commercial Motor Transport Exhibition, which opened yesterday at Olympia, London, that recent legislation with regard to the taxation of heavy lorries will have repercussions on design. Many makers are seriously putting in hand experiments with the object of reducing chassis weight so that a greater paying load can be carried without exceeding the maximum legal gross load for the vehicle concerned. Since the new taxation is based upon tare weight, a twofold advantage is gained if the chassis weight can be reduced. As yet there has hardly been time for any notable modifications of chassis design to be observable, but the next biennial exhibition should be of great interest from this point of view. The results of legislation are not always those expected by its originators, and it is by no means impossible that, as one firm of trailer builders suggests, the trend of progress may be towards the evolution of light power units drawing trailers or semi-trailers. The roads certainly would benefit from such a change, since the load would be distributed over a greater number of axles.

Apart from the effects of new legislation, the development of the commercial vehicle proceeds on lines parallel in many respect to those of its smaller sister, the private car. Transmission systems, for instance, are undergoing change, particularly where omnibuses are concerned. In urban areas the driving of an omnibus has heretofore necessitated the frequent changing of gears. This necessity, which, when an ordinary gear-box is fitted, is wearying to the driver, still exists, but by the provision of fluid fly-wheels and pre-selecting gears the labour involved is much reduced, while the driver's attention is not distracted from the road. In lorry work, too, similar "labour-saving" devices are fitted in combination frequently with an increased number of ratios up to six or even eight. A still further step forward has been taken by Leyland Motors, Ltd., in the production of an hydraulic torque converter to take the place of gears altogether. When this mechanism, which we described in our issue of October 13th, is installed as an alternative to the conventional gear-box the driver can concentrate on the steering and control of his vehicle undistracted by the possibility that a change of gear may be necessary. Anything like these various improved transmission systems that increases the ease with which a driver can control his vehicle is quite obviously an important contribution to public safety—a matter of some concern in these days when the number of accidents mounts from year to year. In brake gear, another mechanism important for the same reason, there is a suggestion that the hydraulic system with its advantages of simplicity and automatic compensation, combined with high efficiency, is coming further into favour.

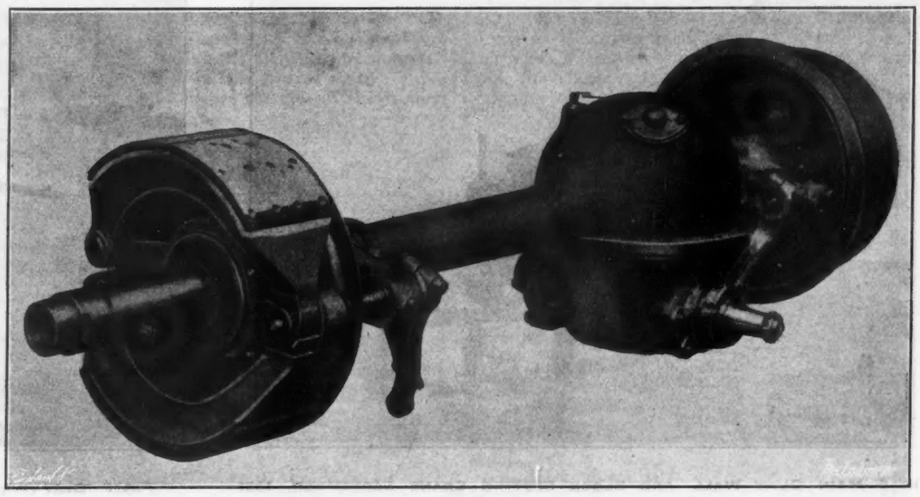


FIG. 1—REAR AXLE OF "HERA" LUXURY COACH—GILFORD

In commercial vehicles of all types, internal combustion, steam, and electric, much concern is now shown for the physical comfort of the driver. Not so many years ago he was only protected from wind and rain and snow by a low dashboard, but nowadays he is enclosed in a compartment approaching in comfort that of a closed private car. Warmed electrically, by the engine, or by the boiler, he is able to concentrate on the work in hand unaffected by the climatic conditions.

Just as the question of suspension is being studied for the ordinary car, so in lorries and omnibuses do novel arrangements appear from time to time. But no definite trend in any particular direction appears to be emerging similar to that which suggests that independent springing may be the thing of the future in private cars. Nor in the case of engines does there seem to be any great urge to place it elsewhere than at the front, although in coach design the Associated Equipment Company, Ltd., has already arranged the engine at the side of the vehicle beneath the seats, while in the new "Pug" 2-tonner, by Commer Motors, Ltd., it is placed behind the cab and beneath the body. Greater space for the paying load has been obtained by adopting "forward control" or by carrying the engine on cantilevers ahead of the front axle. But these arrangements were introduced some time ago and are by no means novel.

The steady development of the oil engine continues, and the old trouble known as "Diesel knock" seems to have been largely overcome as a result of careful design of cylinder heads and improvements in injection systems. Weight reduction, which has become of even greater importance as the result of recent legislation, is perhaps now the most pressing problem facing high-speed oil engine designers. The development of even smaller oil engines for road vehicles is foreshadowed by the fitting of a 45 B.H.P. Perkins engine in a 1½-ton chassis. In steam lorries the necessity for a driver's mate is no longer present, since automatic stokers are being fitted. In fact, the interior of the driver's cab is becoming more and more like that of the internal combustion lorry. It is now enclosed in the same way, while the coal dust that used to be associated with it is absent. Among electric vehicles the trolley omnibus is making great strides into popularity as a substitute for trams without the latter's disadvantages. The most notable change recently has been the development of regenerative braking equipment. But the battery-propelled vehicle seems to make little or no further progress into favour in new fields of usefulness.

GILFORD MOTOR COMPANY, LTD.

Except for the O.S. 4 3-ton chassis, the exhibits of the Gilford Motor Company, Ltd., of High Wycombe, are confined to omnibuses and coaches. The "Hera" super-luxury coach attracts attention, not only by the richness of its furnishing, but also from the design of its chassis—Fig. 2. As befits a vehicle of this class, it is equipped with a six-cylinder engine, capable of developing 118 H.P. at 2500 r.p.m. Its R.A.C. rating is 45 H.P., and it has a fuel consumption of approximately 8 miles per gallon. The arrangement of the cylinders is in two blocks of three each, and Ricardo heads and wet cylinder liners are fitted. The engine is mounted on a three-point suspension system. Careful consideration has been given to the design of the four-speed gear-box, and as a result a third gear ratio was chosen, such that the speed of 30 m.p.h. could be reached without unduly racing the engine. This gear is thus particularly useful in congested streets and the coach is able to maintain high average speeds in such neighbourhoods. The drive is taken to the rear wheels through fully floating axle shafts. The rear axle is of the underslung type, with the driving and differential gear offset to the near side. In the engraving reproduced in Fig. 1 the arrangement of this axle can be seen, and the width of brake shoe and large drum diameter can be observed. The triple servo braking system is employed, and the hand brake, operating on the rear wheels, actuates the same shoes as the foot brake through a specially designed compound lever to give lost motion. In the system of levers and rods between the master servo and the brakes themselves, ball bearings are used to support all rotating shafts. The length of the chassis is 27ft. 4½in. and its wheel base 17ft. 6in. The front and rear tracks are not identical, being 6ft. 3½in.

CHASSIS AT THE COMMERCIAL MOTOR TRANSPORT EXHIBITION, OLYMPIA

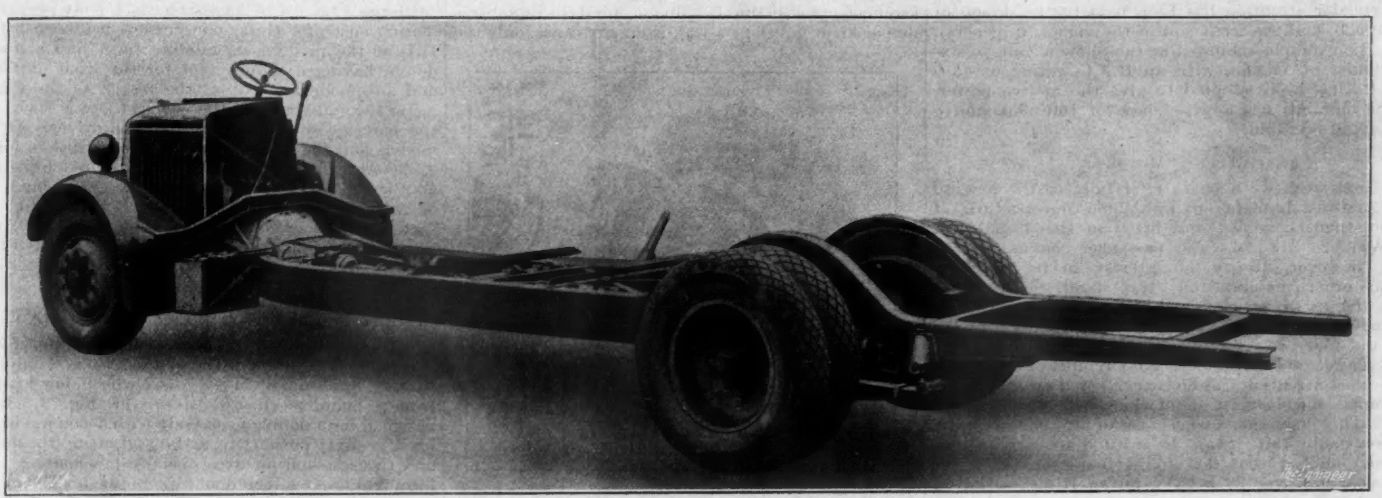

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FIG. 2—"HERA" 32-SEATER LUXURY COACH CHASSIS—GILFORD

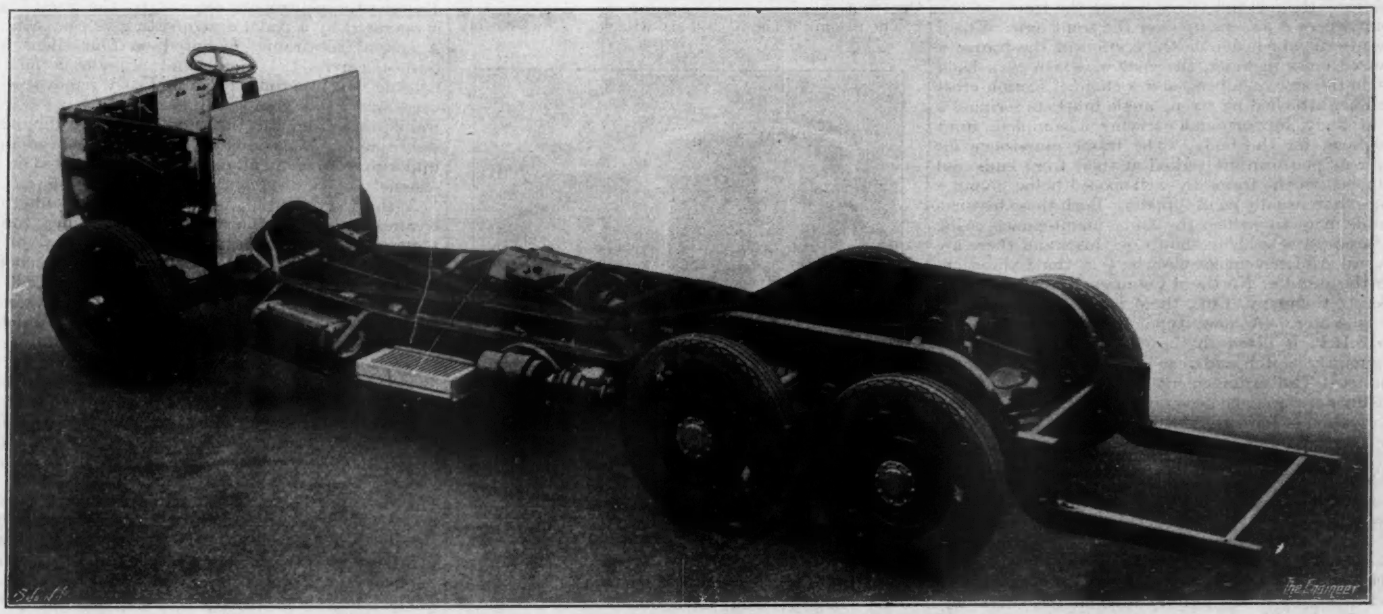
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FIG. 3—SIX-WHEEL ELECTRIC TROLLEY BUS CHASSIS—SUNBEAM

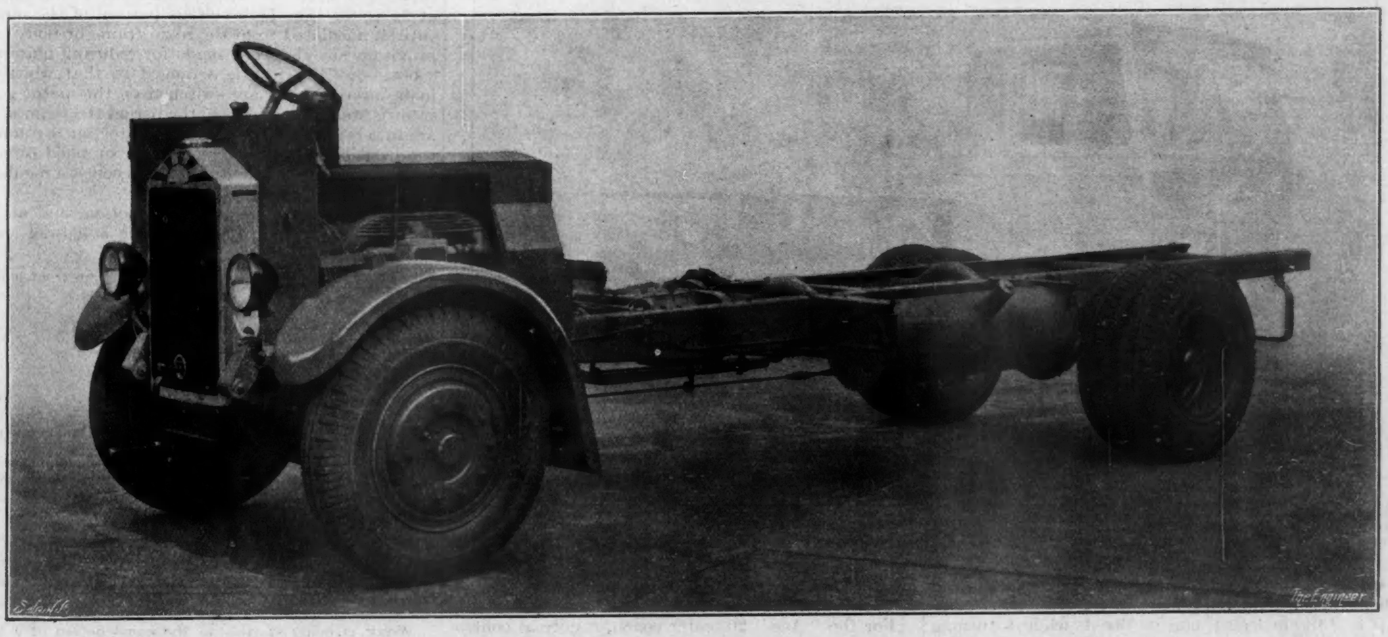
The Engineer

FIG. 4—SIX-TON LORRY CHASSIS—ALBION

and 5ft. 8¼in. respectively, and the overall width of the chassis is 7ft. 5½in. The turning circle is 58ft. 6in. in diameter and the weight of the complete chassis 3 tons 16 cwt.

In the "Zeus" 56-seater double-deck omnibus particular attention has been paid to the design of the cab, and the front end of the vehicle in general. In the example exhibited at the Show a Tangye six-cylinder oil engine, with an R.A.C. rating of 45·9 H.P., has been adopted to give the motive power. The omnibus has a wheel base of 16ft. 3in. and a track of 6ft. 1½in.

ALBION MOTORS.

Next week we hope to refer fully to the new oil engine just brought out by Albion Motors, Ltd., of Scotstoun, Glasgow, and fitted in the 35/85 H.P. "Valkyrie" 32/36-seater passenger chassis. There is, however, plenty of interest to be found in the other exhibits on the stand, particularly as there can be examined there a number of new models. Out of the total of eight vehicles on the stand four are entirely new models and three have never been shown previously at Olympia. Perhaps the greatest attention will be concentrated on the new 6-tonners, the chassis of one of which is illustrated in Fig. 4. This chassis has a wheel base of 14ft. 9in. to carry a lorry body 18ft. long. It is rated to carry 8 tons gross and is propelled by a four-cylinder engine developing over 80 B.H.P., on an R.A.C. rating of 34·2 H.P. Instead of the petrol engine, Gardner or Beardmore heavy oil engines may be fitted. Seeing that the chassis weighs only about 67 cwt., the unladen weight of the lorry, even with a large body, is less than 5 tons.

Among the passenger vehicles the "Venturer" double-decker made its first appearance at the Scottish Show last year. A notable feature of the chassis is the method of reinforcing the frame at the point where it sweeps up over the front axle. There are inserts which double the section of the frame, a pressed cross member, the ends of which turn back inside the side members, and a channel section cross member attached by strong angle brackets forming a front body support and carrying a complete front bulkhead for the body. The frame extensions for the rear platform are forked at their front ends and attached to the frame by well-spaced bolts, giving a more than usually rigid support. Both these features should help to reduce the body maintenance costs.

Besides the vehicles shown on this stand there are several Albion vehicles elsewhere in the Exhibition. On the stand of Northern Counties Motor and Engineering Company, Ltd., there is the new "Victor" 24/26-seater. A new type of engine developing 60 B.H.P. is fitted to the chassis and, besides the engine, the clutch and gear-box are also beneath the bonnet. The arrangement has the advantage that the floor of the coach need not be lifted when gear-box lubrication becomes necessary.

DENNIS BROTHERS, LTD.

Among the firms exhibiting completely new chassis is Dennis Brothers, Ltd., of Guildford. There are three new types altogether, but the features of all closely correspond. They are suitable for a 40–45-cwt. goods carrying vehicle, a 3½-ton six-wheel lorry, and a 20-seater coach respectively, the first-mentioned of which is illustrated in the engraving, Fig. 5. It will at once be observed that the front axle is set well back, and that forward control has been adopted. In consequence, the load is distributed evenly over all six tires, the rear axle with its double wheels taking approximately twice as much load as the front axle. Since the engine is set well forward, it is rendered remarkably accessible. Bodies up to 13ft. in length can be fitted, while a turning circle of only 35ft. 6in. is made possible by the front axle design. The pivot pins are arranged inside the front hubs, as may be seen from Fig. 6. The engine has four cylinders and develops 60 B.H.P. at 2250 r.p.m. An interesting feature of the radiator design is that it is made in four sections individually detachable by the removal of two bolts—see Fig. 7. This arrangement is distinctly valuable, for if the radiator is damaged, or develops a leak from any cause, only the section concerned need be replaced, and the operation may be quickly performed. The safety of the vehicle when travelling fast or in congested neighbourhoods is catered for by the fitting of hydraulic brakes. Shoes, 4½in. wide, are fitted at the back and 3½in. wide at the front.

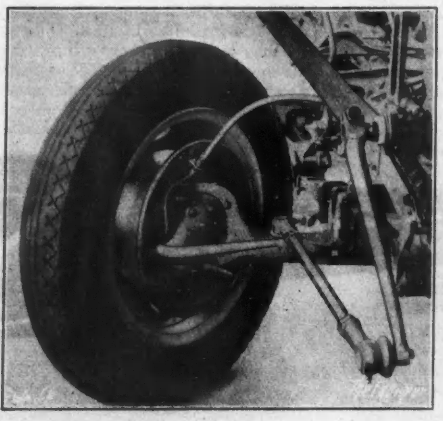

FIG. 6—FRONT WHEEL OF 40/45 CWT. CHASSIS—DENNIS

The design of the 3½-ton six-wheeler follows closely that of the smaller chassis. Its wheel base is, of course, larger, being 11ft. 8in., and the frame is deeper and wider. The trailing wheels are mounted on stub axles secured to the rear ends of rocking beams, to the front ends of which are shackled the rear ends of the rear springs. Bodies up to 15ft. 3in. in length can be fitted and, in accordance with the greater load, the hydraulic footbrake is servo assisted. It operates on all six wheels.

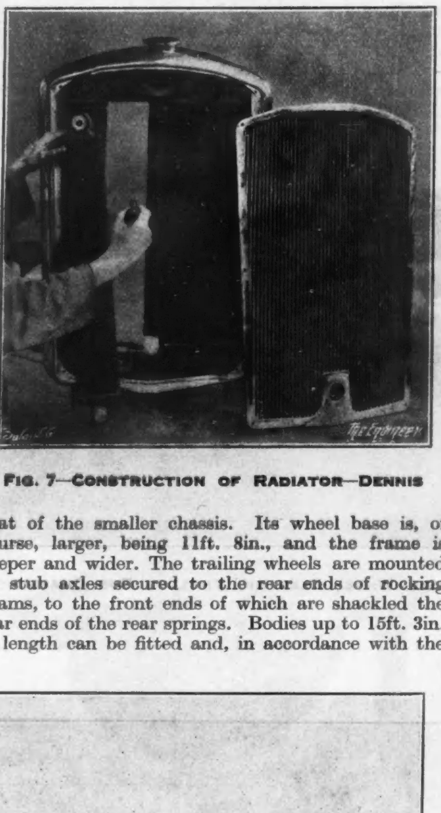

FIG. 7—CONSTRUCTION OF RADIATOR—DENNIS

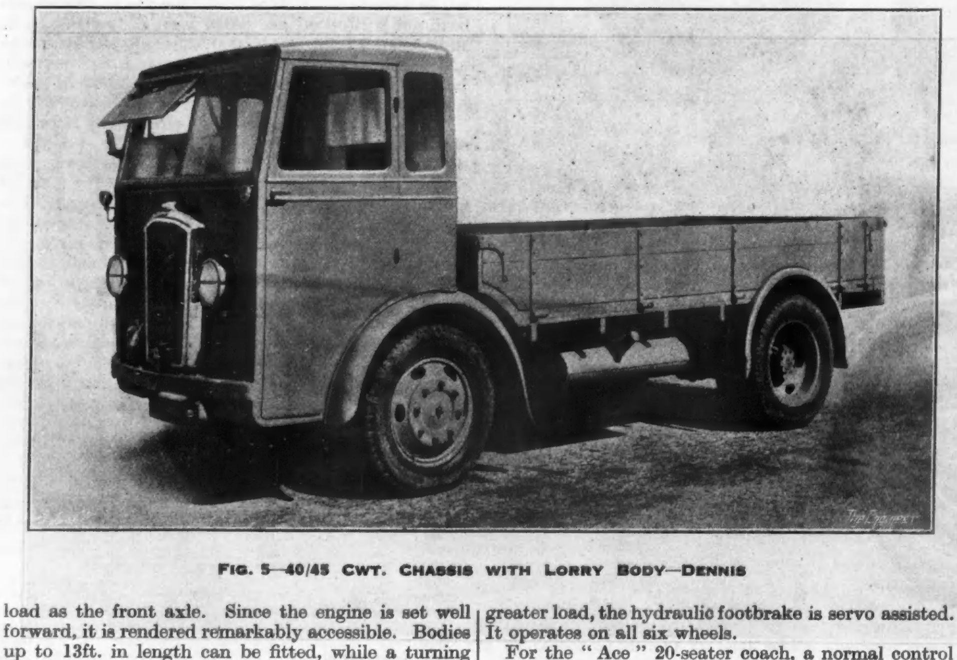

FIG. 5—40/45 CWT. CHASSIS WITH LORRY BODY—DENNIS

For the "Ace" 20-seater coach, a normal control arrangement has been adopted. The chassis is similar to that of the 40–45-cwt. vehicle, but larger, to provide space for a body 18ft. long on a wheel base of 11ft. 6in. The turning circle becomes 40ft. 6in. diameter. In accordance with modern ideas, the interior of the coach is richly furnished and has luggage racks, rug rails, ash trays, &c.

On the "Lancet 6" chassis a coach body providing seating space for thirty-one persons has been fitted. It is of the modern stream-line form, and is a new design having a sliding door for the front entrance and an emergency exit at the rear. As the cab is made the full width of the coach, there is space for the carriage of luggage beside the driver. Other models on the stand are a Lancet chassis for a 32–36-seater body driven by a four-cylinder engine; another fitted with a double-deck body built by Metropolitan-Cammell-Weymann Bodies, Ltd., to seat fifty persons, is fitted with a six-cylinder Armstrong-Saurer oil engine, developing 97 B.H.P. at 1800 r.p.m.; and lastly an 80 H.P. rescue tender and canteen van for the West Ham Fire Brigade.

THE SUNBEAM MOTOR CAR COMPANY, LTD.

Among the exhibits of the Sunbeam Motor Car Company, Ltd., of Moorfield Works, Wolverhampton, is the Sunbeam "M S 3" six-wheel low-loading trolley omnibus chassis, shown in Fig. 3. It is designed for a double-deck body with accommodation for fifty–sixty passengers, and by offsetting the motor and transmission an exceptionally low-loading platform and lower saloon floor are obtained. The motor is placed amidships under the seats, thus permitting a clear floor free from obstructions. A short propeller shaft fitted with a universal joint at each end connects the motor with the foremost rear axle. The resistances are placed amidships on either side of the nearest frame member in an accessible position. Main and shunt contactor panels, claimed to be silent in operation, are mounted in the driver's cab. The master controller, secured to the front dash, is operated by a pedal designed to give easy control. A special sub-frame, mounted on four silent bloc bushes, carries the motor and provides a floating housing which permits rapid and easy removal when necessary. It is completely insulated from the main frame, and from the transmission by a rubber and steel coupling, an arrangement that is of considerable importance when an all-metal body is mounted on the chassis.

A third differential mounted on the middle axle ensures even distribution of the driving torque between the two road axles. The brakes are of the Lockheed hydraulic type, with provision for cooling the cylinders, and they operate directly on all the wheels with a minimum loss of power. The system is controlled by a patented master cylinder, which is claimed to give perfect compensation and to ensure protection from complete failure of braking in the event of fracture of any of the pipe lines. Low maintenance costs, infrequent adjustments, and long life are the advantages claimed for the system, a full-scale model of which is shown. Between the foot pedal and master cylinder there is a Dewandre vacuum servo, which serves to reduce the foot pressure required for operation. The vacuum tank is exhausted by a Reavell rotary exhauster driven directly from the forward end of the B.T.H. regenerative motor, which is designed for heavy overloads and for generating at speeds down to 10 miles per hour.

The Sunbeam patented low-voltage lighting system is arranged so that the 40-ampère-hour battery is only used to supply the small amount of current required for the legal lights and accessories regularly in service, such as the screen wiper, horn, bells, &c., the main current load being supplied directly from a motor generator unit. This set consists of two distinctly insulated machines with a continuous rated capacity of 1000 watts, the dynamo delivering current at 24 volts. The high-voltage portion of the unit is entirely insulated from the main frame or body, and provision has also been made for reducing noise and vibration. A switch is arranged so that when the main interior lights are switched on the motor generator is started, and during the period the main lights are in service and the motor generator set is running, the legal lights and accessories are supplied directly from the dynamos and the battery receives a regulated charge.

The chassis is of robust construction, and all the units are accessible. The following is a brief specification:—

Wheel base..	16ft. 8in. from front axle to centre bogie
Wheel base of bogie	3ft. 11½in.
Frame height, laden	2ft.
Frame height of platform, laden	11in.
Overall length of chassis	27ft. 0¾in.
Overall width	7ft. 5½in.
Turning circle (10·5—20 tyres)	Under 60ft.
Front and rear axle track ..	6ft. 4¾in.
Speed	30 m.p.h.
Tyres	10·5—20in. Dunlop low pressure
Motors	B.T.H. 201 compound wound
Resistances	B.T.H. jointless unbreakable
Circuit breakers..	B.T.H. type M.R. 504
Three differentials	
Ratio	10·33 to 1

(To be continued.)

WORK is being started on the construction of a large grain elevator at Fort Erie, Ontario, at a cost of 1,750,000 dollars.

Railway and Road Matters.

The Board of the Institute of Physics has elected Mr. A. E. Tattersall, the signal and telegraph engineer, North-Eastern area, London and North-Eastern Railway, to be a Fellow. We understand that Mr. Tattersall is the first railwayman to receive this honour.

Speaking at the Boatmen's Institute the other evening, Mr. G. Thatcher, assistant manager of the Grand Union Canal Company, said that anything up to a million tons of goods passed annually through the heart of London in the canals without the slightest noise or inconvenience to anyone.

The oldest railway "servant" in Great Britain is believed to be the signal-box bell at Hebden Bridge, Yorkshire, L.M.S. Station, which for ninety-four years has been sounded to herald the stopping of each passenger train. This railway veteran, which bears the inscription "Manchester and Leeds Railway Company, 1839," is still going strong, and it is estimated that it has been rung over 3,000,000 times.

The Board of Trade export table for September shows that during the first nine months of the present year railway material of the following value was sent overseas, the figures for the corresponding nine months of 1932 are added in brackets:—Locomotives, £708,500 (£262,286); carriages and wagons, £358,364 (£538,284); rails, £414,274 (£267,059); wheels, metal sleepers, fish-plates, and miscellaneous material, £558,645 (£592,338).

The Railway Returns for 1932 show that on December 31st last there was a total of 21,555 steam, electric and petrol locomotives, a decrease of 818 during the year. The average empty weight per steam locomotive increased from 47·06 tons to 47·58 tons. The total number of passenger-carrying vehicles was 49,077, a decrease of 707. These had seating accommodation for 2,757,303, a decrease of 15,409 seats. The stock of Pullman cars rose from 229 at the end of 1931 to 261.

On account of the bad water supplies common in North Africa, the Algiers–Oran Railway is contemplating the adoption of oil locomotives, and has recently acquired one of French make. It has an eight-cylinder engine of 920 horse-power, when running at 700 revolutions per minute. Transmission is effected electrically to three motors on the three driving axles. The engine has been proved to be capable of a speed of 75 miles per hour, and will have to work under an atmospheric temperature of 122 deg. Fah.

Experiments which are being made by the L.M.S. Railway at Burnley and Huddersfield, represent, it is believed, the first instances in this country of the employment of slat conveyors for handling miscellaneous general goods traffic direct from rail wagons to road vehicles. The installation at Burnley (Bank Top) goods depôt consists of a slat conveyor, 365ft. long, electrically operated by a 40 H.P. motor working off 400 volts. The conveyor works in a continuous line between the wagon berths and the cart-loading deck. Goods are conveyed from rail wagon direct to the lorry or rail tranship wagon without intermediate trucking, the resultant benefits including increased speed of handling, earlier delivery of traffic to traders, and the avoidance of damage.

It was forty-five years ago on November 1st since the Midland Company's branch from Staveley to Elmton and Cresswell was brought into use. The line was only 7 miles long, and its opening was a minor event. It had, however, the distinction of being the first section of the Midland Railway to be worked by Tyer's tablet system for controlling single lines. A more important railway was opened forty years ago on November 6th. That was the Dore and Chinley, also of the Midland Company. A private company obtained, in 1884, the initial powers to build the line, but was unable to raise the necessary capital. The Midland thereupon acquired the undertaking in 1888. The line runs from Dore, on the main line to the North, to Chinley on the Manchester line, and gave the company through communication between Sheffield and Manchester. It is 20 miles long with a north and south curve at each end; Totley tunnel is 6226 yards long, and Cowburn is 3727, and the gradients, particularly on the approaches to those tunnels, are severe, with long stretches of 1 in 100. Mr. E. C. F. Trench, who, until four years ago was engineer-in-chief to the London, Midland and Scottish Railway, was one of the resident engineers on the Dore and Chinley.

It is officially announced that the branch line of the London and North-Eastern Railway from Spean Bridge on the West Highland to Fort Augustus at the southern end of Loch Ness, is to be closed to all traffic on December 1st. The history of that romantic and exceedingly picturesque railway has been told by Mr. A. Newlands, then the chief engineer of the Highland Railway, and subsequently and until June 30th last, the chief civil engineer of the London, Midland, and Scottish. The story first appeared in article form, and in 1921 was published as "The Scottish Railways: A Sketch of their Growth and Recent Developments," by the *Railway Gazette*. It began by saying that no review would be complete without a reference to the persistent and determined attempts on the part of all the railway companies to obtain possession of the Highlands. "The cunning and daring of the worst of the old Highland 'Caterans' in their southern raids of long ago did not excel the wiles and persistency of the Scottish companies in trying to wrest from the Highland Company a portion of its territory." In 1893 both the Highland and the North British deposited rival Bills for the construction of a railway through the Great Caledonian Valley, but by agreement between them the Bills were withdrawn. The line between Spean Bridge and Fort Augustus was subsequently built by a private company and opened on July 22nd, 1903. The Highland was empowered to work it, but, on April 30th, 1907, that ceased, owing to the loss to the working company. The North British took it over and operated the line until October 31st, 1911, when the railway was shut down by the owning company. On August 1st, 1913, the operation and maintenance were again taken over by the North British, in which company the line was vested in consideration of the sum of £29,500, of which £5000 was contributed by the Inverness-shire County Council.

Notes and Memoranda.

The improvement in the position of the British steel industry this year is indicated by the fact that the average production of steel for the first eight months was 537,700 tons, compared with monthly averages of 438,100 tons in 1932, 433,500 tons in 1931, 610,500 tons in 1930, and 638,600 tons in 1913.

A Norwegian engineer named Skogen has, according to the *Marine Engineer*, invented a type of propeller in which the blades are divided into two or three parts with long intervening spaces. Trials of the radially slotted propeller on a motor boat are said to have proved that the same vessel's speed can be maintained with a propeller speed one-third lower than that of an ordinary screw.

An official return indicates that the general industrial depression is continuing seriously to affect the overseas demand for American electrical machinery and apparatus. The exports of such material from the United States during the six months ended June last attained a value of £3,472,930, as compared with £4,819,380 in the corresponding half of 1932, and £9,053,120 in the similar period of 1931.

A Fuel Research Technical Paper just issued by the Department of Scientific and Industrial Research deals with the determination of the viscosity of pitch. An important technical application of pitch is as a binder in the manufacture of briquettes from powdered coal. The investigation described formed part of a programme of work designed to correlate the laboratory tests of pitch with its suitability for briquette making, but it is probable that the results will also be applicable to other branches of industry. The report can be obtained from H.M. Stationery Office, price 6d.

According to the *Daily Telegraph*, Monsieur Nicholas Florine, an engineer of Russian birth, but a naturalised Belgian, announced at a meeting of members of the Government and scientists that he had devised a means of enabling an aeroplane to hover for several minutes. He has been conducting experiments for two years. The machine he employed is a helicopter weighing nearly a ton, with a motor of 200 horse-power. It has two propellers turning in the same direction, but with the axes inclined in relation to one another. In experimental flights the machine hovered for 6½ minutes at the first attempt and for 9 minutes 58 seconds at the second. This is claimed to be a world record.

Among the results recently found in weathering tests of paints by the German railways is the fact that a natural coating of oxide on steel forms such good protection against rust that its removal prior to painting is not desirable, even to secure better adhesion of the paint film. Surfaces freed from rust by sand-spraying are frequently more sensitive to wear than those which have been freed from rust by hand. Preliminary surface treatment by phosphatising by the Parker or Atrament processes has so far given no definite results. Steel containing a small percentage of copper (0·2–0·25 per cent.) is more anti-corrosive, and has the additional advantage that not only does the paint adhere better, but the further progress of rusting is inhibited by formation of copper oxide.

A committee on bituminous waterproofing and roofing materials of the American Society for Testing Materials has presented a valuable report on accelerated weathering tests of bituminous roofing materials, and also a critical review of the results obtained in the refined ductility tests for bituminous roofing materials reported last year. Important studies undertaken by the Committee include analytical methods for membrane roofing materials, test methods for bituminous emulsions used for waterproofing, test methods for bituminous joint compound for sewer pipe, and studies of expansion coefficients of bituminous products. Papers of interest in connection with the work of this Committee were presented by J. M. Weiss on "The Volatile Combustible Matter of Coal Tar Pitch," and by G. W. Clarvoe on "An Apparatus and Method for Measuring the Consistency of Roofing Putties and Fibrous Roof Coatings."

In the course of some remarks made at the annual meeting of the Cast Concrete Products Association, Dr. Stradling said that the cause of crazing had definitely been discovered and the next step towards its prevention or cure came from the manufacturers' own practical experience. As the result of their pooling of knowledge, together with the technique in which his staff had been trained, Dr. Stradling said that, in his opinion, the problem of crazing had practically been solved from the scientific point of view—solved not by the laboratory alone or the manufacturers alone, but by a combination of the two working in conjunction. Dr. Stradling proceeded to say that he did not mean to imply that the practical problems were over, as it was not known whether the process which was being tried out in the laboratory would be successful. The theory was right and they were working to devise some means which could be installed in works in order that it might be possible to give a commercial guarantee against crazing.

The effect of mill-scale on the good behaviour of paint varies enormously with the type of scale, according to a paper read before the Electro-Chemical Society, of America, by Messrs. U. R. Evans and S. C. Britton. The lower scale on wrought iron can often be left in position without serious effects. The mill-scale on steel varies very much according to rolling conditions. In general, in the authors' tests, descaled steel covered with a good paint has begun to show rust stains sooner than corresponding specimens painted over the scale, but the paint, although rust-stained, has usually remained firmly attached, so that fresh coats can be applied without ill effects. On the scale-bearing specimens, however, attack has sooner or later commenced at cut edges or at breaks in the scale, and this attack has then proceeded sideways just below the scale, undermining it and causing scale and paint to flake off together; in such a state, repainting without thorough scraping is quite useless. For the present it seems that descaling previous to painting is for certain purposes a desirable practice, but it cannot be said that the matter is fully cleared up.

Miscellanea.

The output of the Ketton Portland cement works has just been increased from 75,000 tons to 150,000 tons a year.

It has been decided to construct a new rain water tank of two million gallons capacity within the Rock of Gibraltar.

It has been decided to continue the Plastics Industrial Exhibition at the Science Museum, South Kensington, until January 15th, 1934.

It is estimated that the cost of rebuilding the No. 2 pier at Halifax, Nova Scotia, which was damaged by fire in September, will be 360,000 dollars.

Another train ferry has been ordered in England, by the Nanking Government, for the service across the Yangtze River between Nanking and Pukow.

A large factory which, it is expected, will supply the whole of the home demands for heavy chemicals is to be put up in Bulgaria at a cost of 20 million leva.

The Lady Gwendoline Tin Mine, Cornwall, has been de-watered and got ready for working again. Already 12 tons of concentrates have been sent to the smelters.

The tunnel, 3½ miles long, which is to convey water from the new reservoir of the Galloway Water Power Company to the power station at Glenlee, has been holed through.

South Wales has received its first cargo of Newfoundland iron ore in connection with the recent barter transaction, under which Welsh coal will be exchanged for Newfoundland ore.

The official returns to the Electricity Commissioners for September show that 1,023,000,000 units of electricity were generated by authorised undertakers in Great Britain during the month, representing an increase of 10·8 per cent. as compared with September, 1932.

The quay on the river Thames frontage of the Wandsworth Gas Company is being extended and equipped with hydraulic cranes, so that coal may be brought right in by sea-going steamers. A new plant for recovering benzole and for screening and grading coke is also being erected.

The recently completed Nizamsagar Dam across the Manjra, a tributary of the river Godavary, in India, has a storage capacity of 29,700 million cubic feet and will provide irrigation water for over 1000 square miles of land. The dam is about two miles long and has cost £3,000,000.

A noteworthy feature of the Northern Rhodesian mineral returns for August is that for the first time cobalt was mined on a large scale. This mineral was first produced in the territory at the beginning of the present year; in August the output was 40,000 lb. odd, valued at over £16,000.

"The skyscraper has been a piquant and picturesque episode in the evolution of our American architecture, but the signs are unmistakable that its irresponsible vogue is near an end," is the claim of Charles D. Maginnis, Vice-President of the American Institute of Architects, in a recent article on modern trends in architecture.

J. Waldo Smith, chief engineer of the Board of Water Supply of New York City, during the construction of the Catskill water supply system, and consulting engineer to the Board since his retirement in 1922, died suddenly of heart failure on October 14th, at his residence in New York City. He was seventy-two years of age.

Field investigations by the Canadian Department of Mines appear to indicate that at least 750 million tons of bituminous sand can be mined by open cut methods in the northern portion of the Province of Alberta. On a basis of 12 per cent. bitumen content this is equivalent to 80 million tons of bitumen or 450 million barrels.

According to the *Chemical Trade Journal*, the Nostell Colliery, Ltd., Nostell, near Wakefield, is installing the system of low-temperature carbonisation invented by Mr. H. P. Hird, a director of British Carbonised Fuels, Ltd., Bradford. It is intended that the ultimate capacity of the plant shall be 200 to 250 tons per day. The first unit will be in operation in January, 1934.

During six months, from April to September this year, the passengers, mails, and freight carried on the Imperial Airways routes to Egypt, India, Burmah, and Africa showed an all-round increase of 45·54 per cent., as compared with a similar period in 1932. The percentage increase in passengers was 43·92 per cent. In mails it was 46·18 per cent., and in freight 40·59 per cent.

We are informed that the Federation of British Industries has undertaken to organise British participation in the Levant Fair and will act as official representatives of the Fair in Great Britain. A permanent British Pavilion is to be erected and a large area reserved for future expansion as well as for the private pavilions of British firms. The Department of Overseas Trade is supporting the F.B.I. in the work.

The date for the opening of the next annual meeting of the Institution of Naval Architects will fall on Wednesday, March 21st, 1934. A summer meeting will be held in London next July, at which a special feature will be the reading and discussion of papers on ship resistance problems as investigated by research in experimental tanks. Delegates from abroad representing the principal tanks of the world will be invited to attend.

A large consignment of rubber hose for use in connection with railway braking systems was recently despatched from Silvertown to China, and, at the request of the Chinese authorities, was covered with metal. The reason for this precaution is intriguing, for it was not connected with the climatic conditions, as might be imagined. It appears that, in the past, the rubber has often been torn away and at first train wrecking motives were suspected, but when the truth came to light there were found to be no sinister intentions. The Chinese had found that the rubber made excellent shoes and, regardless of any disastrous consequences to the trains, were in the habit of taking slices from the hose when their stock of footwear was running low. The metal covering will, it is hoped, put a stop to this practice.

HAIFA HARBOUR—CONSTRUCTION OF THE BREAKWATERS

MESSRS. RENDEL, PALMER AND TRITTON, WESTMINSTER, CONSULTING ENGINEERS

(For description see page 426).

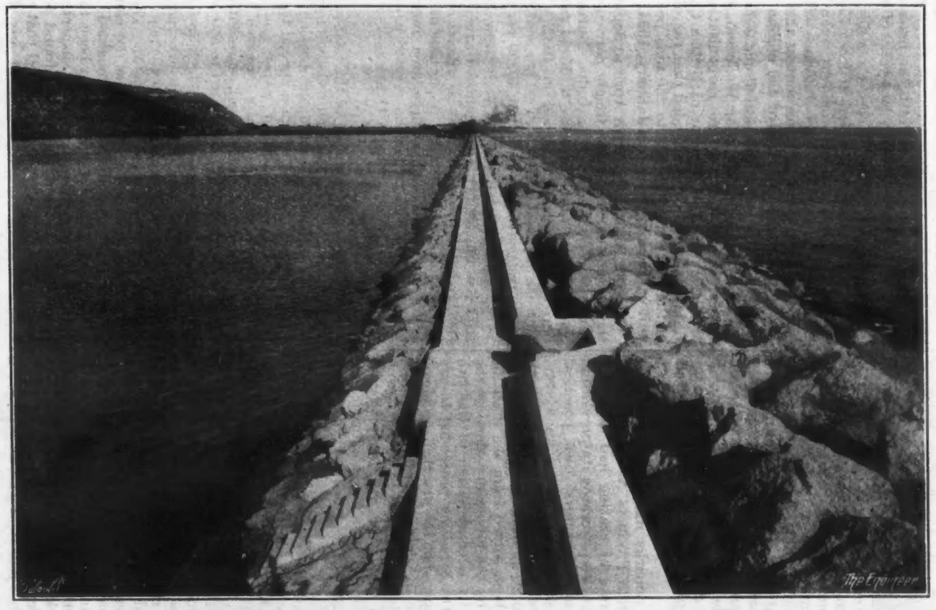

FIG. 8—MAIN BREAKWATER. VIEW LOOKING WESTWARD—AUGUST, 1933

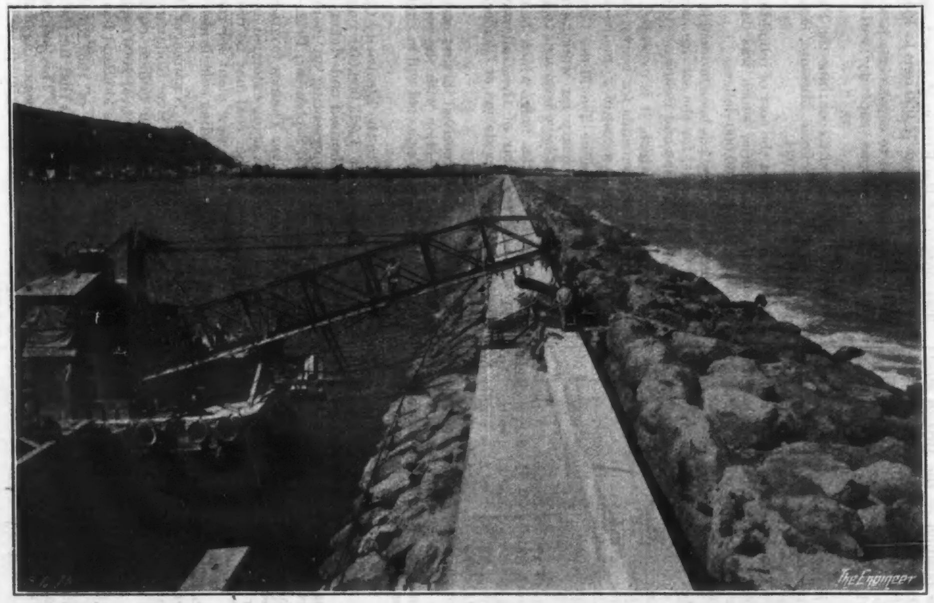

FIG. 9—MAIN BREAKWATER. CONCRETING THE PARAPET WALL—MARCH, 1933

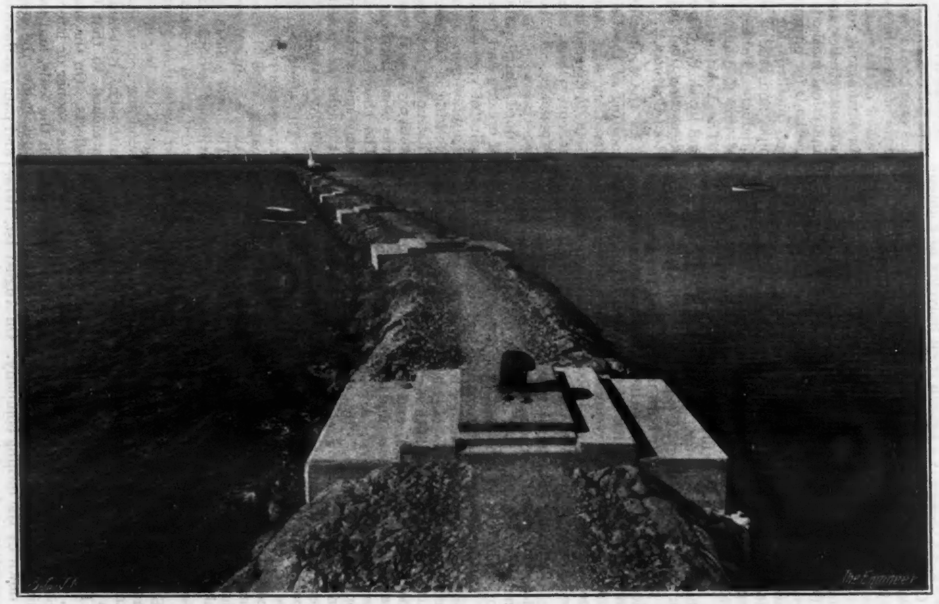

FIG. 10—LEE BREAKWATER FROM SHOREWARD END—AUGUST, 1933

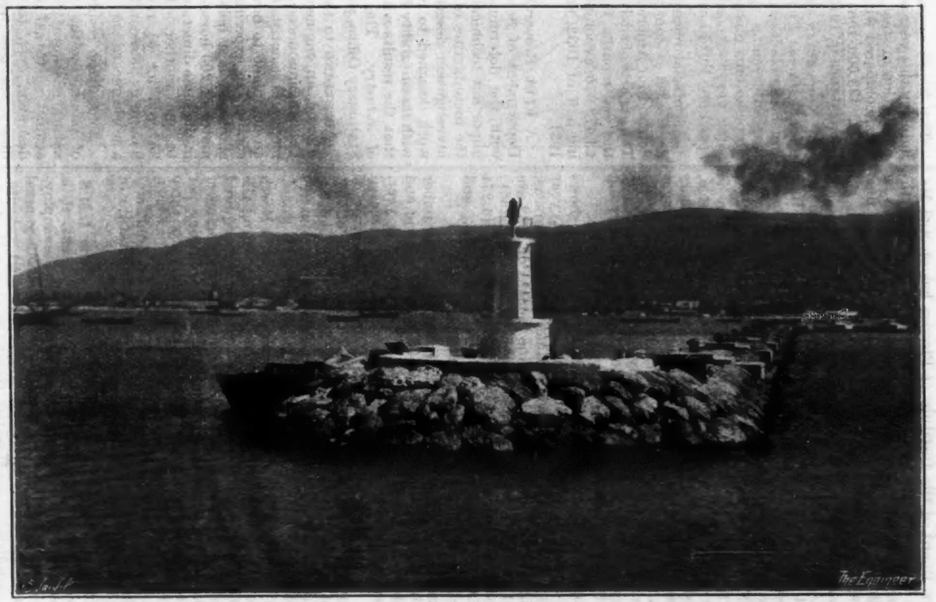

FIG. 11—LEE BREAKWATER AND PORTLIGHT—AUGUST, 1933

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ADMIRALTY CONTRACTS.

Shipbuilders and engineers who specialise in naval construction are looking forward with some confidence to a revival of business in the near future. For months past persistent reports have been current to the effect that a new and long-term shipbuilding programme is to be introduced next year with the object of making good the most obvious deficiencies in our naval defence. So far, it is true, these reports lack official confirmation. On the other hand, there are unmistakable signs that the country is waking up to the vital necessity of maintaining the Navy at adequate strength, and is no longer disposed to accept with equanimity the palpable weakness of our first line of defence. When introducing the 1933 Navy Estimates last March, the First Lord of the Admiralty made it clear that they had been dictated more by the requirements of economy than the actual needs of the service. Since then we have been warned by Earl Beatty and the First Sea Lord, in language the more impressive because of its restraint, that our present rate of expenditure on the Navy is not sufficient to achieve that measure of security which is essential to a country that literally draws its sustenance from the sea. Admiral Sir Ernle Chatfield was debarred by his position from stating the case quite as bluntly as we have put it, but no other interpretation can be placed upon what he did say. It is, in our opinion, all to the good that the Naval administration should speak out at the appropriate time. A Board of Admiralty that remained silent while the foundations of national sea power were crumbling away would be unworthy to hold office. We say this in full recognition of the fact, which Admiral Chatfield was careful to emphasise, that the function of the Admiralty is not to determine policy, but to implement the policy decreed by the Government.

The truth of the matter is that the policy of one-sided disarmament which this country has pursued for ten years has failed. We are not going to pretend that it was adopted purely from motives of altruism. Financial solvency is as much a safety factor as strong armaments, and radical measures had to be taken to restore the nation's Budget to a condition of health. Rightly or wrongly, successive Governments chose to retrench the fighting services more drastically than the social departments, the result being that for many years our expenditure on the former has borne no true relation to their requirements. Neither at sea nor on land, nor in the air, have our armaments been maintained at any fixed standard. Taking the Navy alone, it has already yielded first place in more than one important element, such as size of *personnel*, and every year has witnessed a further decline in its relative strength in man-power and material. Other symptoms of deterioration, less apparent to the public, have been noticed by close observers. To-day, for the first time in modern history, ships are being built for the British Navy which are inferior in many respects to contemporary foreign types. This seems to us a very serious departure from traditional practice, and a form of economy which is most difficult to justify. Another and less obvious consequence of persistent retrenchment at the expense of the Navy has been the steady shrinkage in our mechanical resources for meeting a sudden emergency. Naval armament plants in this country, the finest in the world, have remained virtually idle for more than a decade, and if the process of dismantling them has not been carried to extreme lengths that is largely because their controllers have shown a public spirit and, perhaps, a degree of prevision for which they receive small credit. Even they, however, could not prevent the partial disbandment of that army of highly trained artificers who built the ships of our present-day Fleet. We have said that economy was one of the motives which impelled Great Britain to reduce her Navy, but, side by side with this, was the hope that our example in accepting a quantum of naval strength below our visible needs would be followed abroad. That hope has proved vain. On every hand we see foreign nations busily and purposefully enlarging their war fleets. Five months ago the United States adopted a naval programme embracing forty ships, all of which are to be built within three years at a cost of about £50,000,000. Japan has framed a building scheme of much the same dimensions. France and Italy, both of whom declined to subscribe to the limitation clauses of the London Treaty, have been steadily turning out cruisers, destroyers, and, above all, submarines. Each of these four Powers has, in effect, pursued an independent naval policy determined by what are considered to be the requirements of national safety. Great Britain alone has elected to live, as it were, from hand to mouth, her naval policy—if she had one at all—the shuttlecock between economy and idealism. That game has gone on too long. It is time, as the First Sea Lord admonishes us, to take stock of the situation. Our naval defences are disintegrating, and remedial measures must be taken without further delay. That is why the forecasts of a substantial programme of new construction to extend over several years are probably well founded, and why the industries which have suffered most directly from naval retrenchment are looking to the future with renewed hope. As an example of the tardy rate of building in recent years may be mentioned the fact that work is still proceeding on one or two ships that were authorised as far back as March, 1930, viz., the cruisers "Orion" and "Neptune," at Devonport and Portsmouth respectively. The programme for 1931 has also been so delayed that none of the larger vessels will go afloat before the New Year. One cruiser, the "Amphion," was laid down as recently as last June, twenty-seven months after the date of authorisation. The only contract-built cruiser of this programme, the "Ajax," on the stocks at Barrow, is not due for completion before 1935. Belonging to the same programme, and all building in private yards, are eight destroyers, two submarines, two sloops, and a gunboat. In the 1932 Estimates provision was made for the construction by contract of two cruisers, a flotilla leader, and eight destroyers, two submarines, two sloops, a destroyer depôt ship, and a river gunboat, the orders for which were placed some months ago. The 1933 programme is practically a repetition of that for the previous year, save that the number of cruisers has been raised to four. This increase, however, is largely offset by the fact that three are to be of the small and lightly armed "Arethusa" class—5200 tons, six 6in. guns—which, although of value as fleet scouts or flotilla flagships, are not very suitable for commerce defence. As yet only one contract for a vessel of the 1933 programme has been placed, that for the convoy sloop "Bittern," with John Brown and Co., Ltd. It is understood that the remaining ships will not be ordered before next February or March. Every unofficial forecast of next year's programme includes a number of convoy sloops, a type which the Admiralty is reported to be anxious to develop in order to eke out our slender force of cruisers proper. The first vessel of this type, as already stated, has been ordered in advance. Except that she is believed to be of 1500 tons, little is known about the "Bittern." Most naval men would, we believe, prefer a larger ship for convoy work, and it is important to remember that under the London Treaty we are free to build craft of this type without limit so long as they do not exceed 2000 tons, though restrictions are placed upon speed and armament.

Whether or no the promised long-term programme materialises, there is sound reason to anticipate a larger percentage of new construction in the Estimates for next year. In well-informed quarters a substantial increase in cruiser and destroyer tonnage is expected, to make good in part the alarming wastage in these categories owing to age. More than one-third of our present cruiser tonnage is over the age limit of sixteen years, and, therefore, obsolete, while not less than two-thirds of the destroyer flotilla has passed the official span of life. By the end of 1936, when the London Treaty expires, a very large proportion of our naval material will be out of date, and, consequently, not dependable for active service. This is a serious position, the more so in that every other first-class navy will, by the date in question, consist mainly of new tonnage. In his speech at Sheffield recently, the First Sea Lord observed that the Admiralty looked to the skill of shipbuilders and engineers to ensure that whatever new ships the Navy may need will be of superlative quality. They will not look in vain. Once the Government makes up its mind to restore the Navy to that standard of strength which the national safety dictates, the great industries concerned will perform their part faithfully and well. When the great Naval Defence Act of 1889 was passed, doubts were openly expressed as to whether the shipyards and arsenals of the country could cope with the immense flood of new work. As is well known, the great programme was carried through without serious hitch, and this demonstration of our power to create new fleets at short notice had a most salutary effect on foreign opinion. If it is in the last degree improbable that any new building scheme on the scale of 1889 will be forthcoming, there are, nevertheless, good grounds for hoping that the future holds a brighter prospect for all the industries which cater for the needs of the Navy.

Renaissance.

In the printed form of Mr. Alan Chorlton's address, more than in the extempore address which he actually delivered, he reveals himself as a convinced believer that it is by taking thought, and only by taking thought, that this nation can increase its industrial stature. His panacea for the complaints from which he tells this country that it is suffering, is more and more organisation, more and more collaboration, with less and less *laissez faire*, and less and less individual action. He would even set up a Council to prosecute "Research for New Industries," to replace those "which are either leaving us altogether through the competition of other countries, or which will in future considerably reduce their output and the number of hands they employ." He scatters the pages of history with indifferent hands. It is nothing to him that the industry and profession which he adorns owe everything to individual endeavour, to rivalry, and to competition. The world has not been brought to its present position of material comfort by committees and councils, but by the struggles of pioneers, by the efforts to beat a competitor in price or outdo a rival in excellence. All this Mr. Chorlton acknowledges, but he holds that times have changed and that the old plans are no longer as valuable as they were—"what sufficed in the earlier times is now quite inadequate to meet the difficulties of to-day." He seems to demand that a superior intelligence in the form of a Committee should direct the affairs of the nation, and that the individual, save perhaps as a personality directing mass intelligence, should no longer be encouraged.

Mr. Chorlton, we need not say, is by no means alone in these views. Indeed, they might almost be regarded as the current convictions of the day, which sees—or did see till recently—salvation in "rationalisation," and still believes that the best way to make industrial progress is to absorb or be absorbed by your competitors. Is it not possible that this is a phase of modern thought induced by the peculiar conditions which have prevailed since the war, and particularly by the world depression? Some years hence, it may be interesting to turn back to the flood of literature which has swept over the world in the last few years, and has culminated in the Blue Eagle scheme in the United States. With few exceptions, the authors regard the conditions of the day as permanent. They do not visualise a natural return to those which prevailed but a few years ago. Because the world has seemed different for a decade they think it has changed in perpetuity. They forget that this is not the only slump that we have passed through. They forget that the world rose from other depressions and resumed its old courses in contentment and prosperity. Many of them write as if winter had settled down permanently upon industry, a new ice age, and that there was nothing to do but put down national central heating at once. It may be—who shall say?—that these Cassandras are in the right, and that nothing less than unremitting efforts by committees and the State can save industry from decease; but, equally, it may happen that the revival, which seems indeed to have begun, will render nugatory or unnecessary the machinery which inventors are devising for lifting industries out of the slough. If we are taking thought now, we are taking it too late. The schemes which are now being advanced for this thing and that should have been put into operation at the beginning, not at the end of the slump. The doctors will suffer the chagrin of seeing the patient get well without their drugs. And when he is well, it is ten to one that he will return to old methods which served him so well in the past rather than to new which, no one can deny, are lacking in the human appeal associated with individualism. It is not as if the world stood still under the old system. The trouble is not that it failed to advance, but that it advanced too fast. People are not yet able to accommodate themselves to all that the engineer and the scientist have given them. In Sir Josiah Stamp's telling phrase: "The orderly assimilation of innovation into the general standard of life" is at the moment not taking place. The engineer has given mankind a plethora of commodities, and its metabolism—its power of usefully assimilating them—has gone astray.

Mr. Chorlton, as everyone knows, has identified himself with two great schemes of national importance—the "gas grid" and the "water grid"—but it is less well known that he desires to see engineers taking a larger direct part in ordering the affairs of the nation. "If the engineer," he writes, "is so efficient as to have forged ahead by his works, there seems every good reason why he should now take charge of the part of human activity which has fallen so far behind. . . . More definite co-ordinated direction and control for development and extension is necessary, and in this work of national importance, engineers can render good service and should have their full say." Our profound respect for the men of our profession and vocation cannot blind us to the weakness of this argument. The fact that engineers have been so successful in their own specialised work no more implies that they would make good legislators and national administrators than that the success achieved by doctors or shopkeepers especially equips them for taking "charge of the part of human activity which has fallen so far behind." The only special quality which engineers might be expected to bring to their work would be that of logical reasoning. But the logical reasoning of the scientist is very different from that of the national economist. The scientist deals with closely formulated natural laws; his working material is non-human arguments. Not so the national economist who has to handle mass psychology and must—at present—depend rather upon intuition than reason for the direction of his actions. That engineers "should have their full say," we heartily agree; but it is not yet proved that, in matters outside their own ken, they will reveal a more useful type of intelligence than is found in other men and other professions.

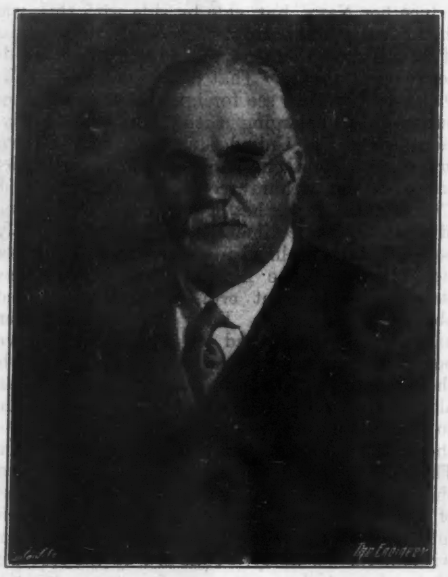
Obituary.

SIR JOHN HARVARD BILES.

Naval architects and marine engineers, both in our own country and in many lands overseas, will learn with regret of the death of Sir John Biles, which took place at his Surrey home, Highfield, Virginia Water, on Friday, October 27th. Sir John was in his eightieth year, and although during the past few months or so his health had suffered, he came up to his office quite regularly until a few weeks ago. His death thus came as a surprise to his many friends.

Few naval architects have lived a fuller and more successful and more varied life. During the sixty years in which Sir John was in practice, he always followed the latest developments of shipbuilding and marine engineering with the greatest of zest, and he himself had the satisfaction of contributing not a little to them. His own work embraced both the design and construction of naval vessels and merchant ships; he spent no less than thirty years at the University of Glasgow as the John Elder Professor of Naval Architecture, and during and since that time he built up a large practice as a consultant. He was senior Honorary Vice-president of the Institution of Naval Architects, and took an important part in the administrative affairs of the Institution and the work of the Council, on which his loss will be most keenly felt.

John Harvard Biles was born at Portsmouth in 1854, and as a boy saw the splendid wooden sailing ships of that port. He served his apprenticeship in Portsmouth Dockyard, and afterwards entered the Royal School of Naval Architecture and Marine Engineering at Kensington, which, during his training, was transferred to the Royal Naval College at Greenwich. He was the first student of his year, and after his training was finished, joined the Naval Construction Department at the Admiralty, which, later, in 1883, was formed into the Royal Corps of Naval Constructors, of his membership of which Sir John was always justly proud. In 1880, at the age of twenty-seven, he was appointed naval architect to J. and G. Thomson, of Clydebank—now John Brown and Co., Ltd.—and subsequently became shipyard manager to the firm, thereby establishing a connection with Clydebank which, through Sir John and Sir J. H. Biles and Co., has remained unbroken. His work at the Admiralty, particularly on the underwater parts of H.M.S. "Thunderer" and other naval vessels, convinced him of the necessity for shorter and broader cargo and passenger liners, and from 1883 onwards he was responsible for the design of many noteworthy ships. The "America" of 1883 made the Atlantic crossing on a record fuel consumption, while two years later the destroyer "Destructor" was built at Clydebank. In 1887 the two Inman liners, the "City of Paris" and "City of New York," were launched, which, with their shorter and broader hulls and well-planned system of hull subdivision, marked a great step forward in liner design. About this time Sir John took a leading part in the progressive change from iron to steel for shipbuilding and marine engineering, and he was attracted to the designing of fast cross-Channel steamers. His name is associated with several Channel boats, and particularly with the Fairfield-built Southern Railway Southampton-Havre turbine steamers, the "Normannia" and "Hantonia."



Sir John Biles

Even in recent years Sir John often spoke of better ships for cross-Channel work, and he was an ardent advocate of larger and longer and deeper ships, with appropriate docking facilities in this country and in France. It is of interest to record that one of his latest patents was for a new system for dry-docking train ferries in which, by the employment of a dock closely fitting the hull of the ship, it is made possible to vary appreciably the train weights without affecting greatly the displacement of the ship, thereby doing away with the long steel aprons generally associated with train ferry landing operations.

In 1891, Sir John was appointed the John Elder Professor of Naval Architecture at Glasgow University, an appointment which he held with honour for thirty years, resigning in 1921, when he received the honorary degree of LL.D. He was also an LL.D. of Yale University. Although, perhaps, not one of the greatest teachers of that great University, he did, with his strong personality, endear himself to his students and private pupils, and in later life he had the great satisfaction of seeing many of them, alike in this country, in America, and in Japan, rise to the highest ranks of the profession.

On relinquishing his University post, Sir John devoted his time to building up his practice as a consulting naval architect and marine engineer. For many years he had served the leading British shipping concerns. His wide knowledge was in constant request for Royal Commissions, Departmental Committees, and Board of Trade inquiries, among the many of which we may perhaps single out for mention the Dreadnought Commission of 1912, the "Titanic" inquiry, and, more recently, the "Vestris" inquiry. He wrote a special article for this paper soon after the loss of the "Titanic"—see The Engineer, April 19th, 1912. He had a singular gift of clearly stating his opinions, and this clarity of expression was greatly appreciated in the many cases in which he was called upon to give evidence. He was knighted in 1913.

Throughout his life he was a personal friend of the late Sir Charles Parsons, and in the early experiments with the steam turbine he supported Sir Charles with his knowledge and advice. Right to the end he remained a strong defender of the steamship, and took the greatest of interest in the varied means for using economically our British coal supplies, collaborating with his partner, Admiral Scott Hill and his staff, in a close investigation of the possibilities of pulverised fuel at sea. He took a real interest in the engineering side of his work and was a member of the Institution of Civil Engineers. His war services included the designing and the supervision of construction of river craft for Mesopotamia, which were recognised by the Secretary of State for India in Council, when, in 1922, he was made a Knight Commander of the Indian Empire. In 1923 to 1924 Sir John was a member of the Indian Mercantile Marine Committee, and the following year he served on the Committee for Royal Dockyards and their organisation, while from 1925 to 1926 he was chairman of the Engineering Joint Council. His published works included "The Steam Turbine as Applied to Marine Propulsion," and "The Design and Construction of Ships," which was to be followed by a third volume, which, however, he did not find time to write.

Reference may be made to his many papers and contributions to the "Transactions" of the Institution of Naval Architects, which, in themselves, are a tribute to his great knowledge and many-sided activities. Alongside his great technical and scientific knowledge, he possessed an innate capacity for business and hard work, and never spared himself. In his hours of relaxation he did, however, reveal a charming and kindly personality, and memories of after-luncheon and after-dinner conversations at the Athenæum, or at the Royal Society, will for long remain bright recollections of his own personal friends.

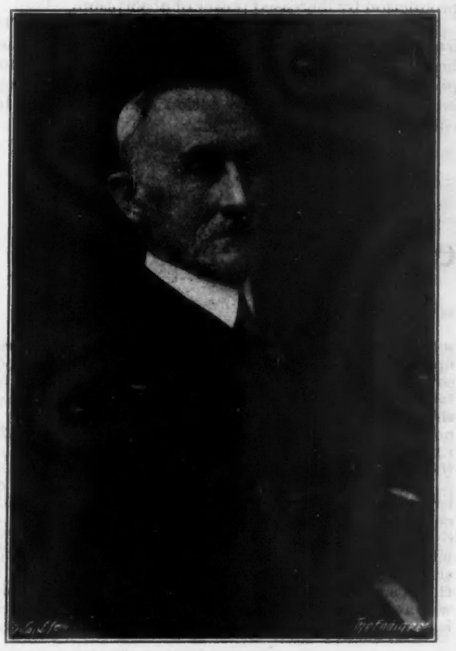
SIR ALEXANDER C. HOUSTON.

It is with very great regret that we have to record the death of Sir Alexander Houston, the Director of Water Examinations to the Metropolitan Water Board. Sir Alexander died at his home in Hampstead on October 29th, in the sixty-ninth year of his age.

Alexander Cruikshank Houston was the eldest son of Surgeon-General John Houston, of the Indian Medical Service. He was educated at Merchiston Castle School and at Edinburgh University and graduated as a Bachelor of Medicine in 1889. At a very early date in his career he exhibited an inclination to depart from the ordinary paths of a medical calling. In 1891 he graduated as a Bachelor of Science and a year later he received the degree of Doctor of Science. Questions of public health claimed his interest, and from 1893 onwards, until his appointment to the Metropolitan Water Board in 1905, he worked on various aspects of that subject for a number of different bodies. For the Local Government Board he conducted an important and prolonged investigation into lead poisoning produced by moorland water supplies. During the years 1898 to 1900 he was employed by the London County Council on sewage disposal experiments at Crossness and Barking, and subsequently studied the bacteriology of watercress beds and milk supplies. From 1899 to 1905 he served as bacteriologist to the Royal Commission on Sewage Disposal, and in the last-named year was bacteriologist to the Lincoln Corporation during the typhoid epidemic which broke out in the city. His connection with the Metropolitan Water Board may be said to date from 1903, when he was engaged in an expert capacity in the arbitration proceedings which led to the establishment of the Board as an authority superseding the old water companies. Following his appointment as the Board's Director of Water Examinations, he still found opportunity to place his knowledge and experience at the disposal of other bodies. In 1907 he acted as British representative on an International Commission appointe to inquire into the water supply of Cairo. In the sam year he took part in the Belfast Health Inquiry.

With Sir Alexander Binnie he visited Ottawa in 1913 to report on that city's water supply.

It is by his work for the Metropolitan Water Board that Sir Alexander will undoubtedly best be remembered. His annual reports on the purity of London's water supplies revealed him to be, not only a scientist, but an antiquarian, a poet, and a philosopher. These reports, while they might have been purely statistical, were enlivened and raised to a high level of literary and human interest by the infusion into them of the author's enthusiasm for his work and his love for everything connected with it directly or remotely. His attention was by no means confined to what he could see beneath the microscope or in the test tube, but ranged widely over the history and geography of London's water supplies. It would, however, be a mistake to suppose that he allowed these external interests to interfere in any way with the performance of his technical duties. He was charged with the task of protecting the sources of supply and with the solution of problems concerned with the purification of the water. In that work he acquired a world-wide reputation and rendered service, not only to the Board, but to all water supply authorities. Last year, although he had passed the age limit of sixty-five, the Board decided to retain him in his post. In coming to that decision it recorded its opinion that his work "lightened the grave responsibilities of the Board and tended to create a sense of security among those who watched over the health of the Metropolis."



SIR ALEXANDER HOUSTON

Three weeks ago it was announced that it had been hoped to retain his services until at least September, 1934, but that his health had compelled him to tender his resignation.

Sir Alexander was created a Knight of the British Empire in 1918 and a year later was made a Commander of the Victorian Order.

Institution of Mechanical Engineers.—The annual dinner of the Institution of Mechanical Engineers took place on Thursday evening, October 26th, at the Dorchester Hotel, Park-lane. The chair was taken by the President, Mr. Alan E. L. Chorlton, and more than 520 members and guests were present. After the loyal toasts had been given and honoured, the President called upon Sir Ernest W. Petter to propose the toast of "Our Export Trade." In the course of his remarks Sir Ernest referred to the difficulties which the exporter was called upon to face, both with regard to restrictive trade regulations and finance, and he appealed for further Government help in removing these disadvantages. In responding to the toast, Mr. Walter Runciman, President of the Board of Trade, spoke about the Government's difficulties in the matter of holding the scales evenly in trade agreements. As Sir Ernest Petter had pointed out, much had been done for the coal trade, which, he claimed, represented the easiest and most direct way to influence other trades. The Government, he continued, was not unmindful of other industries, and would welcome the help of engineers in solving difficulties still presented. One disadvantage in the past had been the over-capitalisation of industry, a problem which was now beginning to come to an end. He thought that the adaptability of the British manufacturer had not yet been fully exhausted, and suggested that what was most needed at present was a spirit of hope in business life. Half our population was directly dependent on export trade, and it was satisfactory, he recalled, that we were now shaping ourselves on a much more economic basis than we had since the war. The toast of "Our Home Production" was proposed by Mr. H. N. Gresley, Vice-president, who referred to the improved state of trade, which was shown by the railway traffic returns. More wagons were needed, and whereas a year ago wagons under repair were not missed, to-day more wagons were needed. The Minister of Transport, Major Oliver F. G. Stanley, replied to the toast, and commented on the remarkable safety of railway travel. He thought it was the task of the mechanical engineer to make car and road transport, which was on the increase, safer. The toast of "The Institution of Mechanical Engineers" was given by Mr. J. C. C. Davidson, Chancellor of the Duchy of Lancaster, and in his reply the President put forward a strong plea for the greater recognition of mechanical engineers in general affairs. They might be fairly regarded, he suggested, as the architects of industry.

The Engineer and Conditions of To-Day.*

MECHANICAL engineering in one form or another has been, from the early days of the industrial revolution, a most potent force in changing the easy-going ways of the "good old times" to the intensely active and involved life we have to live to-day. In that interval the country has changed from being almost entirely agricultural to being mainly industrial, and has enormously increased in population and wealth. This great period of expansion was one of mechanical invention as applied to almost all industrial processes, the steam engine, the locomotive, textile machinery, mining, iron and steel production, assisting the development of all, making possible many new industries, and constantly finding new paths for further progress.

Up to the time of the war we lived in what was certainly an age of expansion, and all our views, actions, and constructive work were based on that aspect. Our industries and mode of life were developed in such an atmosphere—what sufficed in the earlier times is now quite inadequate to meet the difficulties of to-day. The world now is a very different place from those expansive pre-war days, for it has not only reached, but has already passed through some of the years of an age of contraction.

The old *laissez faire* policy of the Victorian age, the individualism under which our industrial supremacy was built up (in which mechanical engineers played so great a part directly or indirectly), the manner of growth of our towns with their public utilities, all form part of an age now gone by, when the margin of profit available for all purposes was large and the general conditions favourable, all no doubt the result of the great industrial lead, so rapidly gained after the Napoleonic Wars, and then held for so long over other nations.

In this age the individual was predominant, or, if it were the question of a town, then in its development the will of that town alone must prevail without much regard to others surrounding it. In all this progress, whether for individuals or communities, the engineer laboured with a success so constant and so assured, as to be accepted so much as a matter of course, that in the end his real value was all too frequently overlooked. He was seldom entrusted with the original decisions; it was the financier, the politician, local or national, or the administrator who claimed the right to direct. These people, so often self-appointed, belonged to a class who had acquired the dangerous habit of believing they possessed an inherent ability to govern and decide without technical training.

That the engineer, with one of the widest trainings of all professions, was so rarely associated with these prime councils of decision may have been partly his own fault, due, perhaps, to the fact that he was largely self-centred. His work brought its own satisfaction, and he was content if his developments succeeded and led to others of an even more interesting character. He was seldom interested in world movements, being more concerned with specific problems which he could tackle on logical lines. Although the enthusiasm of the inventor stirred him to picture to himself the benefits which the application of his ideas might bring to his fellows, he probably derived greater satisfaction from the accomplishment itself. In this way he was led from one development to another, each a stepping-stone to a further success, urged forward by those who stood to gain financially to a pace in which the absorptive power of the world has quite failed to keep up with him.

Before the war, when progress was much slower, the balance between consumption and production could be maintained, and the engineer had not then experienced the intense urge to increase his speed and output brought upon him by war and post-war claims.

It seems rather strange that those who are now blaming him, in reality for his success—economists, financiers, politicians, and even those engaged in social services—do not see the implication arising from their charge. If the engineer is so efficient as to have forged so far ahead by his works, there seems every good reason why he should now take charge of the part of human activity which has fallen so far behind.

Much has been said of rationalisation, amalgamation, and co-ordination in industry, and of the need for general re-equipment. In fact, the plethora of advice given to industry by those not concerned in and without experience of it, has become wearisome by its constant reiteration. It seems rarely to have occurred to these people that such methods can also apply to the re-equipment of the country itself, quite apart from the actual industries, and that this aspect is now within their purview. From a consideration of this subject it will be seen that the need for more co-ordinated working and an improvement in our public services is urgent, if we are to increase the general facilities for industry and the amenities of social life and at the same time secure some real saving from the waste which at present obtains.

In this work the engineer, who has been responsible for the construction, erection, and successful functioning of the already existing equipment, is the one well qualified to direct and carry on the art, and it must be concluded that to bring this about most efficiently, some form of engineering and industrial council would have to be set up. We already have the Economic Advisory Council, and it is to be regretted that another body of the nature indicated was not created at the same time, and the responsibilities and duties of the two properly interlinked.

Such an industrial council has been advocated before, and there is no doubt a wide range of most useful work exists for it to carry out, on lines somewhat similar to those of the Economic Council, but in this address I am dealing with mechanical engineering with particular relation to practical schemes of public work comprised in the larger project of the re-equipment of the country.

I envisage the situation to-day as being one in which we must, as an act of government, improve the facilities of the country in proper relation one to the other as is now being done in industry, with the object of bringing them up to the same level of efficiency as that of the most advanced industry, for they contribute in no small degree to the general effort we are making to regain our position against the competition of other nations in export trade, upon which our existence so much depends.

The various public services of the country—light, heat, power, and water supply—have all been developed separately with but little interconnection, yet everyone will agree that if they had been properly inter-related, a much more efficient system would have resulted as a whole at a far smaller first cost, with greater satisfaction to those who must use them. Similarly, drainage, sewage, cleansing, and many other public utilities, have been developed piecemeal by separate towns and districts. Railways, roads, and canals also afford examples of "how not to do it," by their lack of proper inter-relation with each other, resulting in high costs, ruinous competition, and consequent waste.

Water Supply.—This, to-day, is a separately conducted service, either by municipality or by company. Generally, there are ample supplies of water, but in rural areas all too frequently they are very limited.

Numerous Royal Commissions and Committees have reported on this question during the last fifty years, and have pressed in the national interest the need for some improvement and control of the various sources of supply. They urge that it is necessary to set up a Central Water Authority to act as an advisory body, and to control the allocation of water and the collection of supplies.

The country, as a whole, is well provided for, but the rainfall of different parts is very varied. Naturally, the deposition is greatest in the hills, principally in the Pennines and in Wales.

In the past industrial development in the North has used up so much of the Pennine supply that there is little left, but it is doubtful whether industry will continue to increase there. An increase in industrial activity is indicated in the southern areas and around London, with a corresponding increase of population, whilst a decrease in population in the North may be expected.

This change will affect the water supply more than any other public utility. It is undoubtedly being felt even now, and already there is, in many northern towns, a considerable reduction in demand. Not only has the London area to face an increased demand as the new industries expand, together with that from more rapidly growing population, but the consumption per head rises also as baths become more numerous and sewage systems become universally water-borne. For the London area, with a population of perhaps 12 million, an increasing consumption per head, and the growing requirements of industry, a much greater supply will be required, perhaps ultimately twice the present amount.

If the foregoing factors are taken into account, together with the large demands that will arise in the countryside itself, it seems that we shall have redundancy in some parts of the country and scarcity in others. It is suggested that a scheme should be worked out whereby areas with heavy rainfall, like those of the hills, will provide, by suitable trunk mains, the supply to those parts of the country where it is or will be required. It is an imperative need that the whole of the available water supplies of the country should be investigated and a scheme, of which the foregoing is but a suggestion, developed by which they can be more evenly distributed, and the manner of control might be by an authority similar to that administering the electricity scheme.

Gas.—The case for expansion here bears a family resemblance to that of water, in that it also implies the inter-connection of existing undertakings somewhat upon the lines of the electricity grid. But it is also to some extent bound up with the question of long-distance supply and is a proposal of long standing.

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* The Institution of Mechanical Engineers. Extracted from the address by the President, Alan E. L. Chorlton, C.B.E., M.P.

The proposal to generate gas at the pithead and transmit it under pressure by pipes relatively long distances to the areas of large consumption must have been brought forward in the very early days of the industry.

Though the gas industry began in this country and subsequently spread to others, it has lagged behind in regard to later developments in connection with long-distance supply, and in considering this question to-day we have to go abroad for most of our examples. There are doubtless very good reasons for this. In the earlier days installations were of a more primitive character and relatively isolated, coal was cheap to transport, and as time went on legal restrictions became so encircling and so preventive of outside development that all available talent was concentrated on the plant itself, resulting in this country taking the lead over others in the design and construction of gas production plant for towns. It is difficult to set out adequately to what extent gas has been handicapped by legislation in this country, but it has been a very real limitation.

This limitation has not only been restrictive in the distribution of profits with its obvious reaction, but generally, in the areas of distribution and supply; in effect, no gas company could act in a major sense, as, for instance, concluding an agreement with a neighbouring undertaking, except by special Act of Parliament.

No doubt, the earlier projects for the long-distance transmission of gas were based upon some simple comparison that it was more economical to transport gas than coal. To-day, however, the whole economic problem of the transmission of energy by coal, gas, or electricity, has been carefully investigated in detail, but it is exceedingly difficult to apply figures directly in every case. Considered as an engineering problem, the basis of any present-day scheme would be, as with the electricity grid, to inter-connect the highly efficient stations by trunk mains to the areas previously supplied by the older stations and in this the comparison is close.

The next condition is one in which the gas problem differs from the electrical. While special new power stations have been erected for the electrical scheme, the extra supply of gas at low cost actually comes, or will come, from the coke oven installations, either existing or being erected at the pitheads of various collieries, from which gas is blowing to waste.

The general development of coal mining, particularly in certain areas, points clearly to the considerable increase in the number of these installations. We have thus available, or shall have, a very large amount of gas for use, and accordingly the gas grid system has a considerable advantage over the electrical, both from a capital and an economic point of view.

Had the coke oven installation advanced at a more rapid rate, the question of a widespread gas supply, apart from legal considerations, would have been forced to the front earlier—in fact, before that of electricity. Examination of the two schemes reveals close similarities, but there is one important difference: the gas has, or will have, a large excess supply from which to draw, whilst the electrical undertaking has had to create it by heavy capital expenditure on new stations.

When we come to a more detailed consideration of the gas scheme, naturally we find many differences of the conditions of supply in various towns, also the thermal value of gas is not constant throughout the country. No differences can, however, be greater than those which existed in the case of electricity, and are probably less, and, moreover, they present no fundamental difficulty which cannot be overcome by patience and experience.

All such widespread schemes for the supply of our common needs—electricity, water, gas, &c., and their interworking—must be properly administered if the highest efficiency is to be obtained. As examples of interworking we can consider :—(*a*) Electrically driven pumps for the water grid, operating during periods of least demand to obtain the lowest possible rate for current; (*b*) gas engine driven pumps in the coke oven areas for the water grid; (*c*) electrically driven pumping for gas on a similar basis; (*d*) gas engine driven electric generating stations, using cheap gas from storage as the supply for peak electrical loads; (*e*) water storage systems to act through turbines on electricity supply systems; (*f*) the foregoing, combined with water supply systems in some cases.

The proper use of all these forms of energy (for each has supreme advantages in certain applications) is absolutely essential if an efficient national scheme for all is to be developed. It is one which would be in advance of any already existing in other countries.

There are a number of other common services, apart from those mentioned, in which improved efficiency, considered from the point of view of the general re-equipment of the country, would be obtained if they were so co-ordinated, inter-related, and extended.

For instance, the development of the sewerage and drainage systems of the country should promptly follow that of a general water supply. This is essential in villages where the risk of epidemic arises, not only directly, but also from the reaction on the water supply of an inefficient sewage disposal system. There is also the question of the drainage of large areas of the country, a matter which has been the subject of much investigation and of many recommendations, which, at any rate in modern times, have been carried out but rarely.

Continuing the examination of the subject, we might take that of transport, where there is already a considerable development of the modern trend of co-ordinated and centralised control. The rapid development of the commercial vehicle on the road has forced the adoption of a plan of inter-working between road and rail, and the extension of this principle will continue.

The development of waterways, examples of which are the Grand Union now in progress, and the Nottingham–Humber scheme practically completed, indicates that the long neglect of this important system of transport is coming to an end. The numerous canals that are out of use must be considered for other purposes, perhaps in certain cases for rural water supply.

Up to the present, road building has occupied far too prominent a place in the undertaking of public works. The old policy should not be revived, but there are undoubtedly many bottle-necks still left in the country which could advantageously be removed; some at the entrance to towns and others at cross roads almost nullify any gain afforded by the new main roads.

The question of road bridges and level crossings over railways is important, and a vast amount of work would arise if this were satisfactorily settled.

If we regard speed as one of the absolute needs of the railway, as compared with the road, it would not be unreasonable to assist the railways to ease their own bottle-necks. But a far more important question is that of the electrification of suburban railways. The industrial areas of South Lancashire and the West Riding of Yorkshire, densely populated as they are, and threaded by a close network of railways, are particularly suitable for such a development. It would result in much work for many trades, and a great improvement in travelling and transport facilities.

All that is possible should be done by the Government to assist these areas in retaining their particular industrial suitability, for the retention of their existing manufactures and in the development of new trades if the older ones fail. If trade fails, the migration of population may eventually leave the northern areas derelict.

Time will not permit of the consideration of every other scheme of national re-equipment which might with advantage be undertaken, but they are many, and all must bear their due relation one to the other and to the whole, and in each the mechanical engineer can play a great part. There is, however, one more service I might refer to, in which the suggested Council or a section of it might give great assistance, which I will call "Research for New Industries." The specific object of this would be to discover by intensive investigation new industries to replace those which are either leaving us altogether through the competition of other countries, or which will in the future considerably reduce their output and the number of hands they employ. Such new industries might either be of a nature similar to those they replace, or of an entirely new character, designed to assist in redressing the present balance of over-production by increased power of absorption.

The more generally accepted way, of course, is to leave matters like this to the initiative of individual firms. Under present conditions this way has not proved sufficient. World conditions are too strange and distorted; collective action seems again to be called for.

Mobile Generating Set.

SOME time ago we had the opportunity of inspecting one of the 67-kW mobile generating sets for battery charging, constructed by William Beardmore and Co., Ltd., at their Glasgow works, to the order of the Engineering Department of His Majesty's Post Office. By the courtesy of the Engineer-in-Chief to the Post Office, we are now able to describe and illustrate this machine.

These generating sets are designed to supply current for telephone exchanges at times if the normal electrical supply fails. Similar sets are now situated in London, Manchester, Birmingham, and Leeds.

Each unit, two of which are shown in Fig. 2, is constructed in the form of a complete electric power generating unit, together with all the necessary equipment usually associated with an electric generating set. The oil engine is of the four-cylinder airless-injection four-cycle type, of British design throughout, and is direct coupled to a shunt-wound D.C. generator, supplied by the British Thomson-Houston Company. The engine and generator is shown in Fig. 1.

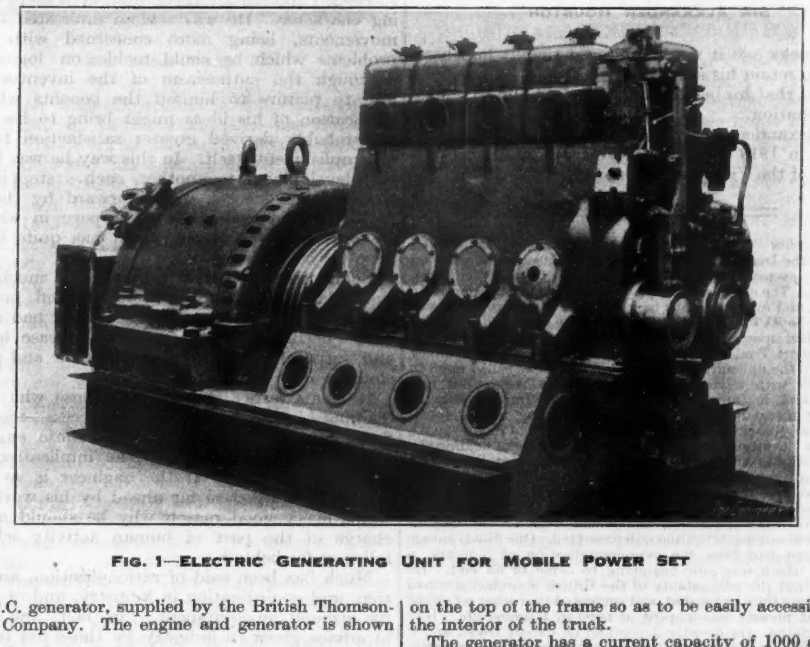


FIG. 1—ELECTRIC GENERATING UNIT FOR MOBILE POWER SET

The entire power unit is mounted on a platform built up of rolled steel channel sections, and is enclosed in a mild steel canopy. Suitable sliding doors give access to the control levers and the equipment.

The unit is carried upon four wheels fitted with solid rubber tires, and is sprung with four semi-elliptical springs. The front axle is carried in a swivel truck with drawbar to facilitate transport. All the wheels are adequately braked, and each wheel is fitted with Timken roller bearings.

The canopy and chassis were manufactured by Carrimore Six Wheelers, Ltd. The general design of the set is illustrated in the drawing, Fig. 3, from which it will be noted that the cables for coupling up from the generating set to the storage batteries are carried, when not in use, upon the rear end of the canopy, the housing of which covers the radiators, while the lower part forms a chest for tools and spare parts. The generator is of the one-bearing, shunt-wound, self-excited, direct-current type, giving a normal output of 67 kW when running at a speed of 1200 r.p.m. The dynamo has been specially designed to meet the conditions of service required in a mobile charging equipment. The frame has no feet, but is supported on two substantial bars welded to each side, resting directly on the chassis of the vehicle and giving a low height of centre. The machine is self-ventilated with two pipe inlets at the commutator end, which are connected by short lengths of trunking to the sides of the vehicle, so that a supply of clean cooling air is obtained from a point well away from the heat of the engine. The air discharge is downwards at the driving end. Terminals are arranged on the top of the frame so as to be easily accessible from the interior of the truck.

The generator has a current capacity of 1000 ampères, at any voltage from 24 to 80. The voltage range is obtained partly by varying the speed of the engine from 550 to 1200 r.p.m., and partly by a rheostat in the shunt field. The output thus varies with the speed, being 24 kW at the lowest speed and 80 kW at the highest. Hence, the engine is always running at about constant torque. The armature carries a self-equalised lap winding, giving the high degree of equalisation desirable in heavy current low-voltage machines, and designed to reduce the commutation troubles to a minimum.

When running at the highest speed and voltage there is a considerable margin in the field rheostat, and if all this were cut out an excessive voltage would be obtained, resulting in overheating and possible breakdown of the field windings or rheostat. To prevent this, a fuse with a high resistance in parallel is arranged in the field circuit, so that if the field current reaches a dangerous figure, the fuse will blow and the high resistance will reduce the current to a safe value.

The switchboard is equipped with a 1000-ampère automatic single-pole Salford circuit breaker, a double-pole knife switch, 6in. diameter voltmeter and ammeter, the latter being provided with two scales to read from 0 to 750 and 0 to 1500 ampères, together with fuses and switches for controlling the electric lights provided in the power compartment. Each switchboard bus-bar is coupled up to three conductor couplings securely fixed to the side of the canopy, to which the flexible cables are coupled for transmitting the current from the generator to the telephone exchange. Both the voltmeter and ammeter are spring mounted to prevent damage due to the transmission of road shocks during transit. From Fig. 3 it will be seen that the engine and electrical controls are arranged at a central position adjacent to the switchboard, so that the entire set is under the control of the operator for adjusting the voltage output before closing the circuit breaker connecting up to the storage battery, provision being made by means of a change-over switch to read independently the voltages of the storage battery and generator on the voltmeter scale.

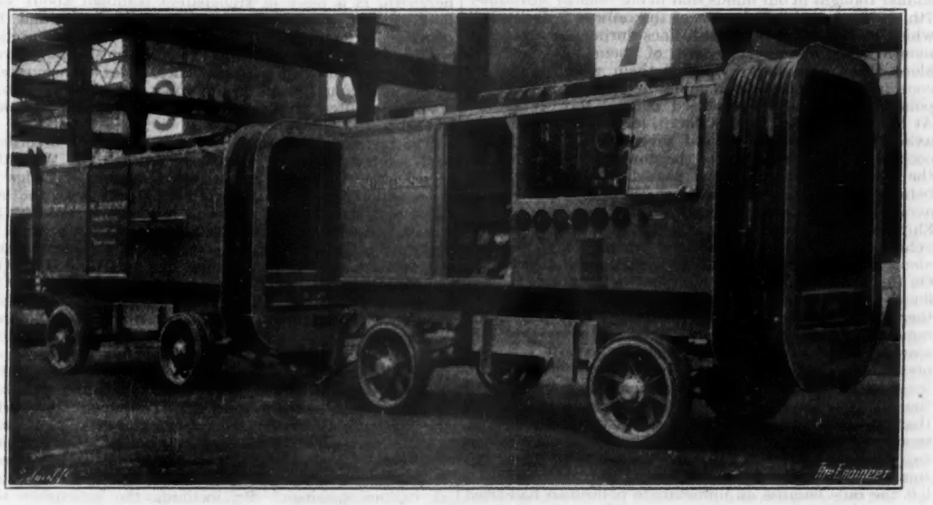

The Engineer

FIG. 2—67 kW MOBILE POWER SET

Careful consideration was given to the design of the cables in order to obtain the necessary degree of flexibility and to facilitate handling. It was ultimately decided to provide a conductor consisting of 940 tinned copper wires of 0·029in. diameter with vulcanised Indiarubber covering. Each unit carries eight 60ft. lengths of cable, each length being fitted with screw couplings capable of carrying 600 ampères. The couplings are of the plug and socket type supplied by Simmons and Stokes, Ltd. To prevent damage to the contacts, light-screwed covers are provided, as shown in Fig. 5.

To lessen the noise set up during normal running of the generating set, the canopy is divided into two compartments, the partition being arranged adjacent to the engine coupling and the engine compartment lined with Celotex slabs of the acoustic type.

The design of the engine follows generally the lines of the Beardmore high-speed oil engines which are at work in rail traction service and other fields, and which have been fully described in previous issues, with the exception of the introduction of minor modifications required by this particular application. The cylinders are 4in. by 6in., with a speed range between 600 and 1200 r.p.m. Governor control is provided to maintain constant engine torque over the entire speed range, this precautionary measure being introduced to guard against the possibility of the engine overspeeding in the event of the circuit breaker being opened through a possible failure in the transmission system.

Special interest attaches to the type of Beardmore fuel pump which the makers have fitted to this engine. It is shown in section in Fig. 4.

The main plunger excentric shaft A is driven from the inlet cam shaft gear wheel, through a two-to-one gear ratio, and therefore runs at engine speed. As the engine operates on the four-stroke cycle, there is only one firing stroke in the two revolutions. In order to attain this, each pump plunger B delivers fuel to two cylinders on alternate strokes, this being obtained by the use of a switch valve C which reciprocates at half engine speed, and is accordingly on its top and bottom dead centres during consecutive strokes of the main plunger, the fuel charge being thus directed to alternate cylinders.

The measurement of fuel and its period of injection is governed by the control valve D, which reciprocates at engine speed and in phase with the main plunger. This valve is formed with two reduced diameters on it, these forming annular oilways between the valve and its bushing. The upper edge of the seal between these oilways is generated in the form of a left-hand helix of small pitch, while the lower edge is generated in the form of a left-hand helix but of larger pitch than the top edge, thus forming a seal which has a varying length of face.

With the main plunger at the commencement of its suction stroke oil is drawn into the cylinder through the suction port E, and annular oilways of the control valve. As the control valve descends the centre seal blanks off the suction port, but overrunning the port allows fuel to be drawn again into the pump cylinder through the control valve upper annular oilway. The discharge stroke of the main plunger then commences and the control valve moves upwards. During the first portion of the stroke, oil is discharged back into the suction main F, *viâ* the suction port and upper annular oilway of the control valve, until the centre seal top helical edge cuts off communication with the suction side, when delivery begins. The control valve still running upwards sooner or later, depending on the load, uncovers the suction port with its lower helical edge, thus releasing the pressure and allowing the oil remaining in the chamber to be discharged into the suction side of the pump.

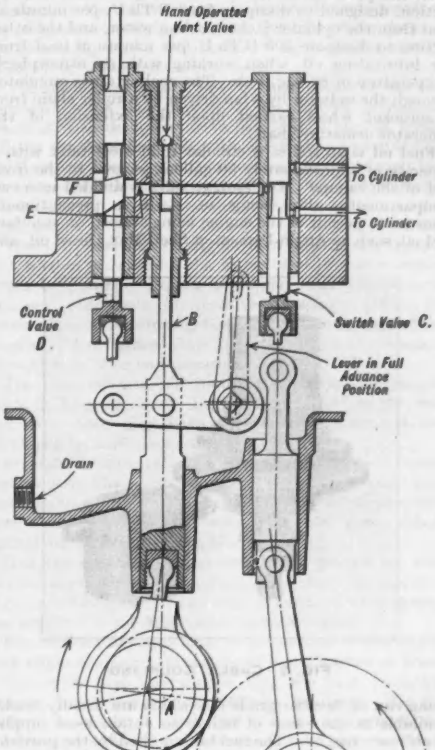

Hand Operated Vent Valve
To Cylinder
To Cylinder
F
E
Control Valve D
B
Switch Valve C.
Lever in Full Advance Position
Drain
A
Intermediate Gearwheel from Crankshaft
"The Engineer"

FIG. 4—SECTION THROUGH FUEL PUMP

It will be seen that the injection period occurs when the main plunger is approximately in the middle of its stroke, and therefore travelling at maximum velocity, the control valve being also at its maximum velocity when the centre seal is in action. A very rapid injection is thus obtained. Owing to the upper edge of the centre seal on the control valve being in the form of a helix, the commencement of injection occurs at different points under varying loads,

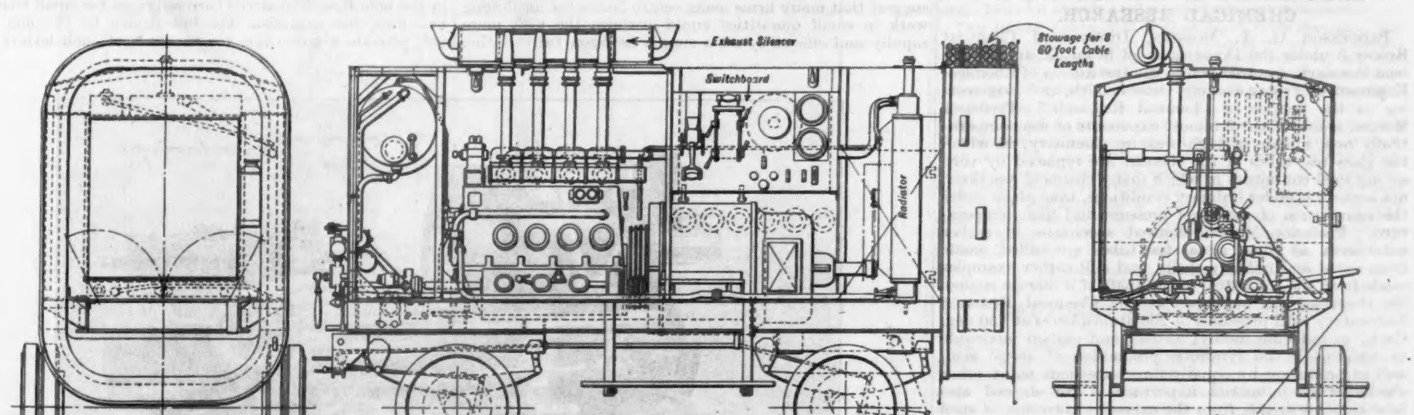

Exhaust Silencer
Switchboard
Radiator
Stowage for 8 60 foot Cable Lengths
Starting Pinion Operating Handle
REAR END VIEW
SECTION THROUGH ENGINE COMPARTMENT
Main Tank Air & Overflow Pipe
Main Tank Drain
Auxiliary Tank Drain
Fuel Pump Suction
Aux. Tank Air & Overflow Pipe
Water Discharge to Radiator
VIEW SHOWING FUEL TANK AND CONNECTIONS
"The Engineer"
Water Suction from Radiator
Cable Couplings
Folding Step on Both Sides of Car
Oil Fuel Filling Connection
FRONT END VIEW

FIG. 3—GENERAL ARRANGEMENT OF MOBILE POWER SET

and the period of injection is either long or short, depending on the position of the helical lower edge of the centre seal relative to the suction port. This position is controlled by the governor. In order to prevent detonation at low speed the control valve can be moved downwards in its relation to the main plunger, thus delaying the injection period. This motion is controlled by the governor speed control mechanism.

A combined radiator of the spiral tube type is mounted upon the platform at the rear of the generating set, one section, designed to dissipate 3900 B.Th.U. per minute of heat from the cylinder jacket cooling water, and the other section to dissipate 500 B.Th.U. per minute of heat from the lubricating oil, when working with an atmospheric temperature of 80 deg. Fah. The cooling air is circulated through the radiator by a fan driven by a roller chain from a sprocket wheel carried upon the extension of the generator armature shaft.

Fuel oil is stored in a circular mild steel tank with a capacity of approximately 50 gallons secured to the front end of the canopy. The storage tank is divided into two compartments, this being in itself a precautionary measure to permit of the engine being started on standard fuel oil, such as Anglo-Persian or Shell-Mex Diesel oil, and being run on heavier grade oils which are usually readily available in the event of failure to obtain local supplies of ordinary fuel oil. The fuel tank is filled by the provision of a semi-rotary type hand pump, the fuel being passed through filters upon delivery to the fuel tank.

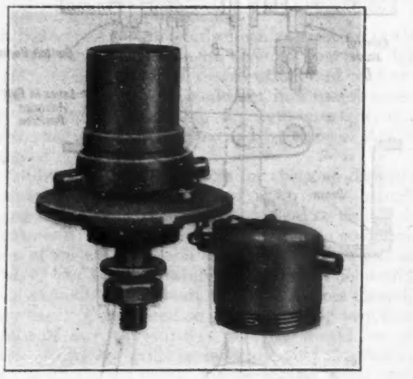


FIG. 5—CABLE COUPLING

The engine is started by a Coventry Victor air-cooled petrol engine, the power of which is transmitted through a roller chain to a lay shaft carrying a frictional bobbin to engage into "V" grooves cut on to the periphery of the main engine fly-wheel.

Each engine was given a six-hour duration test before despatch, and developed 103 H.P. when running at a speed of 1200 r.p.m., the average fuel consumption being 0·43 lb. per horse-power hour and the lubricating oil consumption 0·01 lb. per horse-power-hour. The temperature of the cooling water was maintained at 127 deg. Fah., and the lubricating oil temperature at 118 deg. Fah.; while a variable output test was carried out to demonstrate that the generator was capable of giving the outputs referred to herein.

The total weight of the unit complete with fuel oil, lubricating oil and water, tools and spare parts, is 8·25 tons, which at the maximum horse-power of 110 is equivalent to 160 lb. per horse-power.

ENGINEERING IN THE SERVICE OF CHEMICAL RESEARCH.

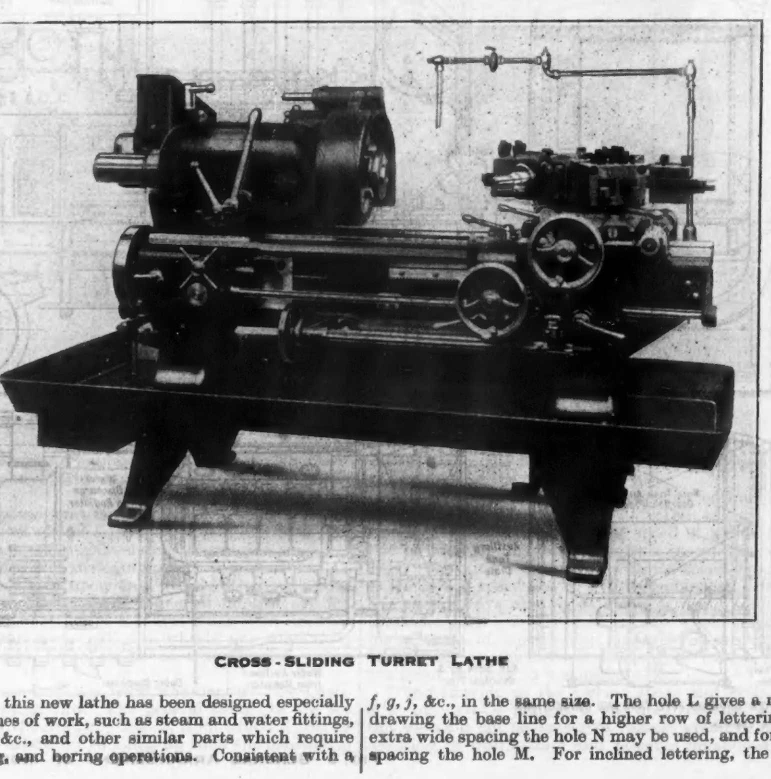
PROFESSOR G. T. MORGAN, Director of Chemical Research under the Department of Scientific and Industrial Research, lectured before the Institution of Chemical Engineers on Friday evening, October 27th, on "Engineering in the Service of Chemical Research." Professor Morgan is one of the foremost exponents of the comparatively new science of high-pressure chemistry, in which the glass test-tubes of the chemist are replaced by very strong steel containers in which many chemical reactions, not occurring under ordinary conditions, take place under the compulsion of increased pressure and high temperature. Professor Morgan showed specimens of earlier autoclaves, as these metal test-tubes are called, made from naval and military shells, and still earlier examples made from the solid steel of the shaft of a marine engine. He described his successes at the Chemical Research Laboratory with pressures of 200 atmospheres at 450 deg. Cent., in inducing methyl alcohol and carbon monoxide to combine in the synthetic production of acetic acid, and in producing by equally direct methods many other chemicals of industrial importance. He showed also how troubles arising from the excessive corrosion of steel found at these high pressures and temperatures had suggested new means for examining the corrosion-resisting properties of steels and new steel alloys, and for devising accelerated corrosion tests by which the life of a particular steel under various conditions of service might be assessed. Apparatus has now been devised at the Chemical Research Laboratory by which experiments can be carried out under 3000 times atmospheric pressure, *i.e.*, at a pressure of about 20 tons per square inch. The pressure-resisting parts for this plant were made from Sheffield nickel-chromium-molybdenum heat-treated steel. The plant is enclosed within steel screens so arranged that the various controls are operated from outside this protection. At the other extreme constituents of coal tars difficult of separation are being obtained at the Laboratory by distillation of the tar at very low pressure—of the order of one-thousand-millionth of an atmosphere—in a plant in which the cold condensation surface is placed so near the substance being distilled that the molecules of the substance it is desired to isolate escape direct to the condensing surface without contamination by others. Professor Morgan also described the plant by which similar separations were being carried out by filtration at a temperature of 80 deg. Cent. below zero.

SIXTY YEARS AGO.

A FEW years ago two crowded suburban trains in the London area, proceeding on parallel lines, "slightly grazed" each other. There was some splintering of woodwork and a brick wall was partially demolished. No one, however, was injured or killed, and because of that fact the accident was dismissed—in unofficial quarters, at least—as of little moment. It was evident, however, that in the features of the mishap there were all the elements for a disaster of the first magnitude. Only by the fortuity of circumstances did it escape from that category. It is perhaps a human failing to judge the gravity of a railway or other accident by the number of victims which it claims. Clearly, however—in official quarters, at least—the gravity of an accident should be assessed not so much by the actual roll of casualties as by the deaths and injuries which it might have caused, but for some split second or other freak of chance such as attends most accidents, and upon the occurrence of which no one has any right to rely. It was doubtlessly with a similar thought in our minds that in our issue of November 7th, 1873, we published a list of the railway "disasters" which had occurred on British lines during the preceding month. There were thirty-five of them. On one day alone there were five. Most of them were, no doubt, considered by the general public as trifling, but, as we pointed out, each just escaped being "terribly fatal." At Shipton, on the North-Eastern, for example, a broken axle in a goods train caused several trucks and their contents to be thrown on to the down line, along which the Newcastle mail train had passed only half a minute before. At Goring, on the Great Western, disaster was avoided by an exact reversal of the circumstances at Shipton. Two goods trains collided and some of the vehicles were thrown off the line, but not on to the line along which a mail train passed immediately afterwards. On the North-Eastern, and next day on the South Devon, flocks of sheep strayed on to the lines. In both cases there was slaughter among the sheep, but the trains remained on the rails. Both mishaps were probably scarcely noticed in the daily Press, but exactly a month previously a bullock which strayed on to the South-Western line near Guildford caused a derailment and smash, and the deaths of three passengers. That it required even less than the body of a bullock to derail a train was demonstrated by another accident included in our list. At Euston two carriages left the rails and ended their career by smashing their sides against the edge of a platform. They left the rails because an unfortunate policeman had tried to cross the line in front of the train. The mail train from Scotland to Euston was on the point of starting when it was discovered that the bolts fixing the tire to one of the engine wheels were broken. It was probably considered merely as an incident, but a fortnight later the tire of a fish truck wheel came off on the Great Northern near York, and the truck left the line. A double accident on the South Leicestershire line seems to have escaped being "terribly fatal" by the incidence of doubly fortuitous circumstances. A Midland engine during foggy weather collided, while shunting, with a goods train. Subsequently, a Midland mail train ran into the *débris*. Probably further mishap was avoided by the extra caution with which other trains were proceeding because of the fog. There was no actual loss of life, because it so happened that there were no passengers in the mail train.

Cross-Sliding Turret Lathe.

THE small cross-sliding turret lathe illustrated by the accompanying engraving is a new production of Alfred Herbert, Ltd., and is known as the No. 5. The makers suggest that many firms using centre lathes for machining work in small quantities could perform the task more rapidly and efficiently on a simple hexagon turret lathe.



CROSS-SLIDING TURRET LATHE

Consequently, this new lathe has been designed especially for small batches of work, such as steam and water fittings, valve bodies, &c., and other similar parts which require turning, facing, and boring operations. Consistent with a high standard of performance, such that the machine can compete with more elaborate and expensive turret lathes, its design has been kept as simple as possible. All machining operations are carried out by tools held in a hexagon turret, which is provided with automatic longitudinal and transverse motions. Changes of the rate of feed are effected by the operation of a finger controlled pilot wheel on the feed box, and the feeds obtained in revolutions per inch are indicated by large figures on the dial. Bed covers of the usual Herbert design are attached to the left-hand side of the saddle.

Manormus Drawing Instrument.

A NEW drawing instrument, known as the "Manormus," has been submitted to us for our inspection and trial by Mr. H. Castan, 27, Torrington-square, London, W.C.1, who informs us that arrangements are now being made for its manufacture in this country. The device, illustrated herewith, is a piece of transparent celluloid about 7in. long by 3¼in. wide, with one end at right angles and the other at 75 deg. to the lower edge. The face is perforated with a number of holes arranged for the most part in rows parallel with the 75 deg. edge. These holes are accurately drilled and countersunk on the upper face so as to permit a sharp pointed pencil to be inserted through any one of them.

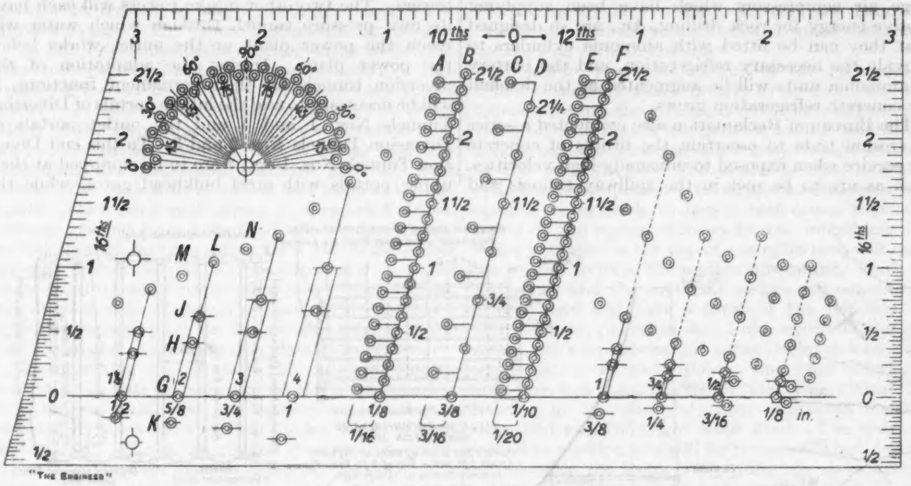
The manner of using the instrument will be described with reference to the row of holes marked D. With the lower edge of the instrument resting against the edge of a tee-square, the tee-square is held steady with the left hand and the point of a pencil is inserted through the lowest hole of the row. With a little pressure applied to the device by the disengaged fingers of the right hand, the pencil is moved to the right or left. Guided by the device the pencil point traces out a straight line on the paper beneath. The pencil point is then moved into the next hole and a second line is drawn and so on, the lines being drawn for preference alternately from right to left, and from left to right. The result is a series of parallel lines accurately spaced at ¼in. apart. If the row of holes marked C is used in conjunction with those marked D, a series of lines $^{3}/_{16}$in. apart will be obtained. Similarly, the two rows B and A give lines at ⅛in. and $^{1}/_{16}$in. apart while rows F and E give lines at $^{1}/_{10}$in. and $^{1}/_{20}$in. apart. The use of the device in this way provides a ready means of drawing quickly and accurately cross-hatching lines at various spacings. By inclining the tee-square the hatching may be made diagonal, and by a suitable selection of the holes it may be made with alternately wide and close spacings. Since the holes are marked as shown, the rows A–F provide a quick and accurate means of drawing a single line parallel to a given line at any distance up to 2½in. provided the distance apart is a multiple of $^{1}/_{20}$in. or $^{1}/_{16}$in.

A series of lines having been drawn in this manner in one direction, the device may be turned through 90 deg. with the aid of a set square and a similar series drawn across the first. The result will be a series of squares or oblongs according as the same or a different row of holes is used. In this way squared paper for the plotting of curves or frames for tabular matter can be readily produced.

Again, with a drawing pin inserted in the lowest hole of any of the rows A–F, circles of various diameters can be drawn by swinging the device round the drawing pin as centre, while the pencil point is inserted in the hole at the required radius. An accurate series of concentric circles can be drawn in the same manner.

Consider next the holes G H J. With their aid three parallel lines may be drawn. The two outer lines will be ⅜in. apart. If they are used as guide lines for capital letters, then the inner line drawn by the pencil when in the hole H will be at the correct height for small letters matching ⅜in. capitals. The line drawn by the hole K will provide a guide line for the tails of such letters as *f*, *g*, *j*, &c., in the same size. The hole L gives a means of drawing the base line for a higher row of lettering. For extra wide spacing the hole N may be used, and for narrow spacing the hole M. For inclined lettering, the 75 deg.

edge of the device provides the means of drawing guiding lines for the strokes, while for vertical lettering the opposite end may similarly be used. The two parallel lines joining the holes G J indicate the desirable width for the strokes of the letters. In this case it is implied that a No. 2 lettering pen, or one giving a stroke 2 mm. wide, should be used. It will be observed that to the right and the left of the rows A–F rows are provided to facilitate lettering having a height of from ⅛in. up to 1in.



THE MANORMUS DRAWING INSTRUMENT

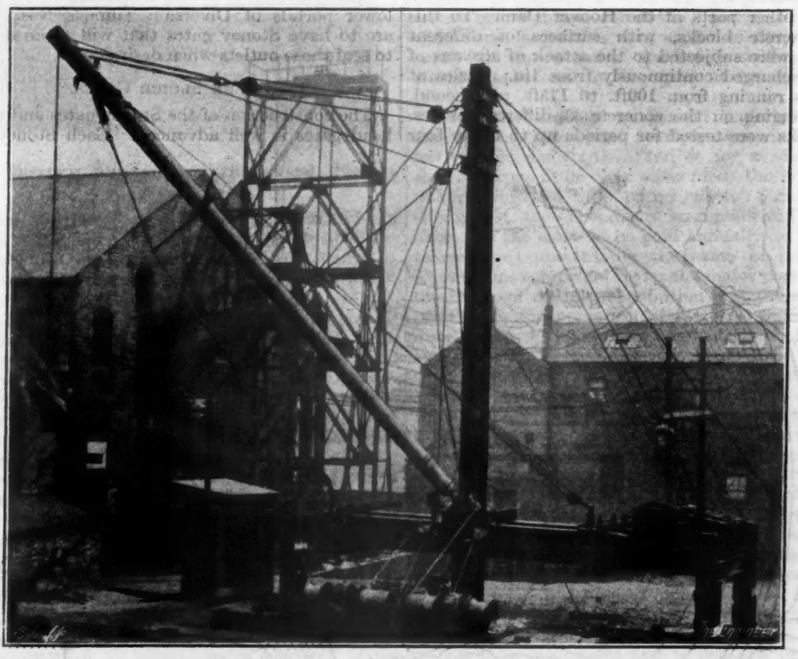
In the case of the rows for the smaller sizes of lettering, additional holes are provided to enable a number of base lines to be drawn at one setting of the tee-square.

A protractor with holes corresponding to angular intervals of 5 deg. occupies the upper left-hand corner of the device, while round three of its edges are scales of inches divided into $^1/_{32}$nds, $^1/_{16}$ths, $^1/_{12}$ths, and $^1/_{10}$ths. For normal use by draughtsmen the device has a plain lower edge, but for artists, sign writers, and others, working at easels, it is found convenient to have a small metal upstanding angle attached along the lower edge.

We have tried the instrument and find it both useful and easy to operate, and to be a pleasant aid in drawing.

Combined Winch and Derrick.

In an article which appeared in The Engineer of November 18th, 1932, we described and illustrated a working model of a combined winch and derrick system manufactured and developed by Clarke, Chapman and Co., Ltd., of Gateshead, by arrangement with the inventor, Mr. George T. MacFarlane, known as the Clarke Chapman MacFarlane patented lifting slewing and topping winch, and derrick system. By means of a three-drum winch, the combined operations of the derrick can be controlled by one man. In the accompanying engraving we illustrate one of these winches, which has recently been built and tested for a vessel now under construction at a Scottish shipyard.



COMBINED WINCH AND DERRICK SYSTEM

The winch is designed to lift 3 tons at 100ft. per minute, 1½ tons at 200ft. per minute, and to operate with a light hook at 400ft. per minute. A hoisting motor of 25 B.H.P., a derricking motor of 20 B.H.P., and a slewing motor of 12½ B.H.P. are provided, all the motions being independently driven by means of worm gear. The controls comprise three vertical handles mounted on one combined master control box, which are shown at the back of the winch barrels in the illustration. A foot brake is provided on the hoisting motion and magnetic brakes are provided on the hoisting, derricking and slewing motions, and a magnetic brake release handle is fitted on the hoisting motion.

By means of the winch a 7½-ton derrick is operated with three-to-one purchase blocks, also a 3-ton load on single fall. Under the test conditions the maximum radius of the derrick was 30ft. and the minimum radius 16ft., the maximum reach of the derrick being 24ft. on each side of the centre line of the ship. With the MacFarlane arrangement, the winchman has all the controls within reach, and can lower the hook, adjust the height of the derrick by the topping lift to the actual position of the load, wind in, swing the derrick outboard or inboard, and adjust the height again before lowering to the required spot. There is no slack in the gear, whether the ship is on an even keel or in a heavy sea, and rolling has little effect on the derrick. The makers claim that all the advantages of a double winch and derricks are obtained without the attendant disadvantages such as the bumping of a load and the rearrangement of the gear which is necessary when loading on different sides of the ship.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

LEAD TRAPS.

No. 504—1933. This new standard provides for traps for use with baths, lavatory basins, sinks, bidets, &c. British manufacturers whose practice it has been to produce traps in accordance with the requirements of the various local authorities have suffered in the past owing to the importation of inferior foreign traps which were neither of the same weight nor measurement and with sometimes very little water seal. This has emphasised the necessity for standardisation on a national scale, and this specification should have the favourable effect of placing competition on an equitable basis. The specification lays down the quality requirements of the material from which the traps are made. It fixes the dimensions, weights, length of inlet and outlet, and the depth of seal. An interesting piece of standardisation is the design of the screw caps. These are fitted to 1in., 1¼in., 1½in., and 2in. diameter traps, and are required to be of hot-pressed brass.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

WATER LOWERING IN QUICKSANDS.

Sir,—In the discussion which followed the reading of a paper on the above subject at a London meeting of the French Society of Civil Engineers, on October 24th, nearly all the civil engineers who spoke lavished compliments on the German "system" of lowering the water level in water-bearing strata and described as novel the method of pumping water from a bore-hole.

The general impression left by these speakers was that German brains and experience had solved a problem which British dock engineers had been afraid to tackle. All the speakers flattered with childlike indiscrimination the "system" and not one referred to the most important feature—the bore-hole pump driven by a submersible electric motor—which had made the "system" easy of application.

There is, however, nothing novel or particularly German in a system of lowering the water level in water-bearing strata by pumping from a bore-hole, as any waterworks engineer could have informed the meeting; nor do the submersible motors driving bore-hole pumps originate from Germany, but rather have been developed in Germany from British ideas and inventions.

The first submersible motor pump was successfully made in England under British patents before the war, and since then they have been greatly improved and developed for various services.

Several Continental countries have adopted British designs and ideas and have for some years past paid royalties to the British patentee of submersible bore-hole pumps accordingly, and whose patents were upheld against strong opposition in Germany.

Had the engineers called for British pumps for such service they could have been supplied without the necessity of going to Germany, or had they understood what system was required in the application of such pumps.

The real novelty appeared in the sudden awakening of dock engineers and contractors to a realisation of possibilities with bore-hole pumps that are now becoming common practice among waterworks engineers. But the deplorable aspect of the affair is that it required the blandishments of German salesmanship to overcome their timidity—the pretext for the introduction of German submersible pumps being concealed by the courage displayed in utilising a new "system." Any waterworks engineer with experience of pumping machinery could have told these gentlemen that the same duty can be obtained with a British patent, British designed and British manufactured submersible bore-hole pump, and that far from German claims being unique, the same, if not better, results could have been obtained by the employment of British resources of brain and manufacture.

If civil engineers and contractors in this country do not exhibit some courage in the attempts being made to encourage home industries, they must be made to realise the enormity of their unpatriotic timidity.

T. L. Reed Cooper.

London, October 31st.

CONTRACTS.

The Port of London Authority has placed a contract for a period of six months with the British Thomson-Houston Company, Ltd., for the whole of its electric lamp requirements.

The Brush Electrical Engineering Company, Ltd., has secured the order for two 11,000-kVA transformers from Kettering U.D.C., to supply Stewarts and Lloyds' new iron and steel works at Corby. The two units will each be 11,000 kVA, three-phase, 50 cycles, 33/11 kV, fitted with remote control "on-load" tap-changing gear.

W. H. Allen, Sons and Co., Ltd., Queen's Engineering Works, Bedford, announce that they have just been favoured with the order for two three-cylinder 100 B.H.P. airless injection oil engines running at a speed of 500 r.p.m., to be installed in a twin-screw trawler operating from Lowestoft. This vessel will be the highest-powered Diesel-engined vessel of its type sailing from Lowestoft Harbour. The engines will be of exactly the same type as those installed in "Dusky Queen," "Boy Clifford," "Helping Hand," &c.

LAUNCHES AND TRIAL TRIPS.

Malaita, single-screw motor ship; built by Barclay, Curle and Co., Ltd., to the order of Burn, Philp and Co., Ltd., Sydney; dimensions, 325ft. by 47ft. by 23ft. 6in.; to carry passengers and cargo. Oil engines, B. and W. Diesel type; constructed by Messrs. Kincaid and Co., Greenock; trial trip, October 14th.

Redwing, harbour service vessel; built by J. Samuel White and Co., Ltd., to the order of the Admiralty for H.M. Dockyard, Devonport; dimensions, 102ft. by 25ft. by 11ft.; launch, October 19th.

Central Flying School, Royal Air Force.—Marshal of the Royal Air Force Lord Trenchard will preside at the "coming-of-age" dinner of the Central Flying School, Royal Air Force, which will be held at the May Fair Hotel, London, on Friday, November 24th. The dinner has been arranged in order to celebrate the twenty-first anniversary of the formation of the School at Upavon in 1912. The School is now stationed at Wittering, Northants. The Organising Committee has been unable to get into touch with many officers of the Royal Flying Corps, Royal Naval Air Service, and Royal Air Force who are eligible to attend, and desire it to be known that the qualifications for attendance are as follows:—All officers who were on the staff of the C.F.S. or who attended courses at the C.F.S. before August 4th, 1914; all officers of the rank of captain and upwards who were on the staff of the C.F.S. during the war; all officers who have been on the staff of the C.F.S. since the war period, *i.e.*, since January 1st, 1920. Officers coming within these categories who wish to be present at the dinner should communicate with the Secretary, C.F.S. Dinner Committee, Central Flying School, Wittering, near Peterborough.

The Hoover Dam on the Colorado River.

No. III.

(Concluded from page 403, October 27th.)

In June of this year the Bureau of Reclamation awarded to four large western cement companies a contract for 400,000 barrels of a special low-heat cement, at a price of 1·40 dollars per barrel. These companies have collaborated with the Bureau of Reclamation in developing types of low-heat cement which have been exhaustively tested. All told, about 100 different cements were subjected to tests, and considerably in excess of 15,000 specimens were examined. The approved low-heat cement is to be used in the main structure of the dam. It represents the outcome of efforts to find means of reducing the evolution of heat in great masses of concrete caused by the hydration of the cement while the mixture is hardening. As is well known, this heat causes pronounced volumetric changes in the body of the concrete, and as the mass cools and contracts the resulting stresses frequently cause more or less serious fractures. There is reason to believe that the employment of low-heat cement will prove of outstanding practical importance, not only in the case of the Hoover Dam, but wherever great masses of concrete are concerned.

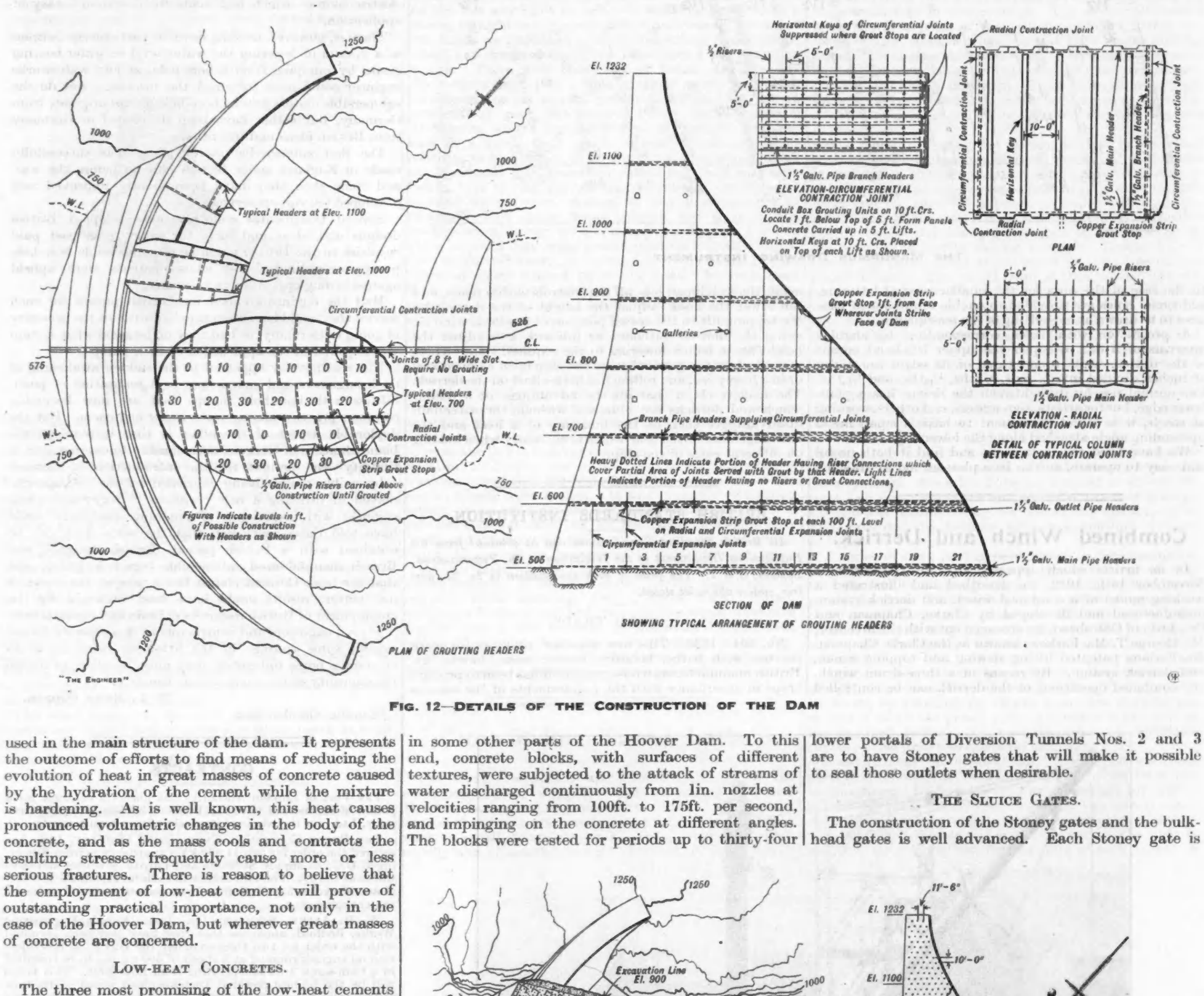

1250
1000
750
W.L.
Typical Headers at Elev. 1100
Typical Headers at Elev. 1000
Circumferential Contraction Joints
525
C.L.
575
Joints of 8 ft. Wide Slot Require No Grouting
0 10 0 10 0 10
30 20 30 20 30 20 3
Typical Headers at Elev. 700
0 10 0 10 0
Radial Contraction Joints
20 30 20 30
Copper Expansion Strip Grout Stops
½" Galv. Pipe Risers Carried Above Construction Until Grouted
Figures Indicate Levels in ft. of Possible Construction With Headers as Shown
PLAN OF GROUTING HEADERS
"The Engineer"
El. 1232
El. 1100
El. 1000
El. 900
Galleries
El. 800
Branch Pipe Headers Supplying Circumferential Joints
El. 700
Heavy Dotted Lines Indicate Portion of Header Having Riser Connections which Cover Partial Area of Joints Served with Grout by that Header. Light Lines Indicate Portion of Header Having no Risers or Grout Connections.
El. 600
Copper Expansion Strip Grout Stop at each 100 ft. Level on Radial and Circumferential Expansion Joints
Circumferential Expansion Joints
El. 505
1 3 5 7 9 11 13 15 17 19 21
1½" Galv. Outlet Pipe Headers
1½" Galv. Main Pipe Headers
SECTION OF DAM
SHOWING TYPICAL ARRANGEMENT OF GROUTING HEADERS
Horizontal Keys of Circumferential Joints Suppressed where Grout Stops are Located
½" Risers
5'-0"
5'-0"
1½" Galv. Pipe Branch Headers
ELEVATION-CIRCUMFERENTIAL CONTRACTION JOINT
Conduit Box Grouting Units on 10 ft. Crs. Locate 1 ft. Below Top of 5 ft. Form Panels Concrete Carried up in 5 ft. Lifts.
Horizontal Keys at 10 ft. Crs. Placed on Top of each Lift as Shown.
Copper Expansion Strip Grout Stop 1 ft. from Face Wherever Joints Strike Face of Dam
Radial Contraction Joint
Circumferential Contraction Joint
Horizontal Key
10'-0"
1½" Galv. Main Header
1½" Galv. Branch Header
Circumferential Contraction Joint
Radial Contraction Joint
Copper Expansion Strip Grout Stop
PLAN
5'-0"
½" Galv. Pipe Risers
5'-0"
1½" Galv. Pipe Main Header
ELEVATION - RADIAL CONTRACTION JOINT
DETAIL OF TYPICAL COLUMN BETWEEN CONTRACTION JOINTS

Fig. 12—Details of the Construction of the Dam

Low-heat Concretes.

The three most promising of the low-heat cements evolved by the joint labours of the experts in the employ of the Government and the cement companies were thoroughly tested for temperature rise, volume changes, and elastic and plastic properties in the laboratories of the Bureau of Reclamation at Denver, Colo. Among the equipment provided for the purpose was a 4,000,000 lb. hydraulic compression-testing machine capable of handling test cylinders of concrete measuring 3ft. by 6ft. The employment of low-heat cement will not alter the prescribed procedure involving the pouring of the dam in columnar sections or block units averaging 50ft. by 50ft. in horizontal cross section, and having circumferential construction joints in addition to the usual radial contraction joints—see Fig. 12. The joints are to be painted and then grouted after the concrete has set and sufficiently cooled. Each lift or pour is limited to a depth of 5ft. in seventy-two hours. After the concrete has set for six days, an artificial cooling system, making use of 2in. pipes imbedded in the concrete, can be brought into action to hasten further cooling—see Fig. 13. All told, there will be 800,000 linear feet of piping, arranged in lines 10ft. apart. The circulatory system will distribute 2100 gallons of chilled water per minute through these pipes. The fluid will have a temperature low enough to reduce the temperature of each unit concrete mass to about 72 deg. Fah. in the course of 2·4 months in the summer time, when the maximum temperature of the concrete, because of the high atmospheric temperture, will be about 134 deg. Fah. A number of the large air compressors which have been supplying motive energy for rock drilling, &c., are so designed that they can be fitted with ammonia cylinders to provide the necessary refrigeration, and the battery of ammonia units will be augmented as the demand for concrete refrigeration grows.

The Bureau of Reclamation also conducted a series of erosion tests to ascertain the fitness of concrete for service when exposed to unusually high velocities, such as are to be met in the spillway tunnels and in some other parts of the Hoover Dam. To this end, concrete blocks, with surfaces of different textures, were subjected to the attack of streams of water discharged continuously from 1in. nozzles at velocities ranging from 100ft. to 175ft. per second, and impinging on the concrete at different angles. The blocks were tested for periods up to thirty-four days. The experiments disclosed that it would be practicable to construct concrete linings for the spillway tunnels, &c., capable of resisting erosion with the water at the velocities mentioned, but it was incidentally proved that the concrete surfaces must be smooth and carefully aligned.

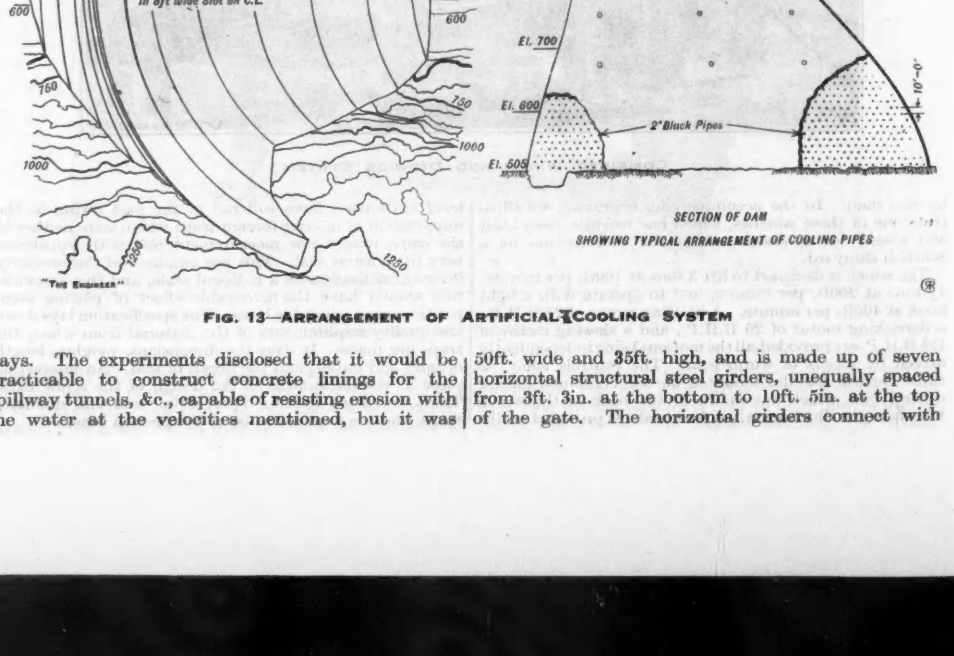

1250
1250
1000
Excavation Line El. 900
1000
750
750
PLAN OF PIPES AT El. 900
Cooling Pipes at Each Level to be Concentric with Faces of Dam
600
600
C.L.
Cooling Pipe Headers to be Placed in 8ft wide Slot on C.L.
600
600
750
750
1000
1000
1250
1250
"The Engineer"
11'-6"
El. 1232
10'-0"
El. 1100
El. 1000
2" Black Pipes
El. 900
El. 800
Galleries
El. 700
10'-0"
El. 600
2" Black Pipes
El. 505
SECTION OF DAM
SHOWING TYPICAL ARRANGEMENT OF COOLING PIPES

Fig. 13—Arrangement of Artificial Cooling System

As indicated in Fig. 1 *ante*, the four big diversion tunnels are to serve as regular operating features of the dam. Diversion Tunnels Nos. 1 and 4 will become spillway tunnels for so much of their lengths as reach downstream from their connections with the spillways. Diversion Tunnels Nos. 2 and 3 will become pressure tunnels linked with two of the intake towers. The two other intake towers will each have its own pressure tunnel, through which water will reach the power plant or the outlet works below the power plant. During the adaptation of the diversion tunnels for their permanent functions, it will be necessary to seal the intake portals of Diversion Tunnels Nos. 1 and 4 and the outlet portals of Diversion Tunnels Nos. 2 and 3. To this end Diversion Tunnels Nos. 1 and 4 are to be equipped at their upper portals with steel bulkhead gates, while the lower portals of Diversion Tunnels Nos. 2 and 3 are to have Stoney gates that will make it possible to seal those outlets when desirable.

The Sluice Gates.

The construction of the Stoney gates and the bulkhead gates is well advanced. Each Stoney gate is 50ft. wide and 35ft. high, and is made up of seven horizontal structural steel girders, unequally spaced from 3ft. 3in. at the bottom to 10ft. 5in. at the top of the gate. The horizontal girders connect with vertical girders at the sides and are covered on the outer or downstream face with steel skin plates $\frac{3}{16}$in. in thickness. The steel cross girders are 51ft. 6in. long, 6ft. 2in. wide at the centre, and 3ft. 7½in. at the vertical girder connections. The vertical girders are approximately 37ft. long and 3ft. 7½in. in width. Two steel ear-plates extend beyond the upper ends of the vertical girders to form connections for the operating hoist chains. Twenty vertical latticework trusses, equally spaced, are employed to stiffen the gate. The concrete structure for the gate —see Fig. 14—contains the counterweight wells; the gate recesses, equipped with guide plates; a rail-protected inspection platform, 56ft. above the tunnel invert; a hoist house extending across the entire width of the structure, with its floor elevation 99ft. above the tunnel invert; and a spiral stairway connecting the inspection platform and the hoist house. The gate is to be raised and lowered by two hoists. Each hoist will consist of a sprocket driven through gearing from a shaft which, in turn, is connected through worm gearing to a 10½ horse-power slip-ring induction motor. A water seal is to be maintained by seal pipes of 3½in. heavy brass tubing, one on each side of the gate; each seal pipe bears against a bronze plate on the outside corner of the gate recess and against the skin plate of the gate.

The operating chains, each 82ft. 10in. in length, run from the gate up and around the hoist sprocket to counterweights, and are constructed of bronze pins 5in. in diameter, and 19in. by 9in. links, of high carbon steel. The motor control consists of a drum-type controller with limit switches for the upper and lower ends of the gate travel. Each of the two counterweights is composed of a steel hanger and nine 11,200 lb. precast concrete blocks. The suspended weight of each Stoney gate and chain, with the gate down, is approximately 261,000 lb., and that of the counterweights and chains is 215,500 lb. The normal hoisting speed is 0·891ft. per minute, and the total lift is 58ft.

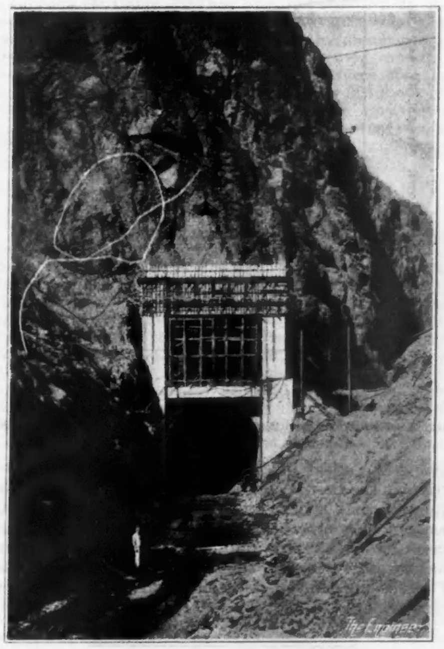


FIG. 14—OUTLET PORTAL OF DIVERSION TUNNEL No. 2

Each of the bulkhead gates at the inlet portals of Tunnels Nos. 1 and 4 is 50ft. wide and 50ft. high. These gates are of much heavier construction than the Stoney gates, because they are designed to withstand a hydrostatic head of 295ft. Except for testing purposes, it is not contemplated that the bulkhead gates will be lifted after they have once been lowered. Therefore, the operating mechanisms for the bulkhead gates have been designed for controlled and sealed closure rather than for recurrent operation, as in the case of the Stoney gates. Each bulkhead gate is made up of nineteen horizontal structural steel girders connected to a vertical girder on each side. The horizontal cross girders are 55ft. 3in. long, and 12ft. 6½in. wide. The vertical girders are 50ft. 5½in. long and 10ft. 6¾in. wide. Connection to the stems of hydraulic cylinders, which control the gate movement, is obtained by extensions of the web plates of the vertical girders. On the upstream side of each gate is a cover plate unit 47ft. wide and 50ft. 6in. high, made of 1in. plates riveted to cross girders, and on the exterior face of this unit are nineteen ⅞in. plates—one for each cross girder. Skin-plate units, 1¼in. thick, are placed between the cross girders at 10ft. 7½in. from the upstream face of the gate. The concrete structure for each gate is 119ft. high, and contains structural steel guides, brackets, roller tracks embedded in the gate recesses, and cast steel stationary wedges fastened to the embedded brackets. An assembly recess is provided above each tunnel entrance, reaching from 56ft. to 119ft. above the tunnel invert, and a foundation and platform are provided above the assembly recess for two large hydraulic cylinders and a control board. The hydraulic cylinders are steel castings 69ft. in height and 7ft. 7in. inside diameter. The maximum piston stroke is 62ft. 5in. Six roller trains of caterpillar type are fitted on each side of the gate to reduce friction. The carriages are attached to cross girders, and the rollers travel on a high carbon steel seat plate set in the concrete structure. The rollers are 14½in. long by 8in. in diameter, and are made of a chilled cast iron alloy, with axles of rolled manganese bronze pins 1¾in. in diameter.

To ensure the tight closure of the gate and to transmit water pressure directly to the gate structure, thereby freeing the rollers, a movable wedge is provided on each side of the gate for its full height, and makes contact with the stationary wedge fastened to the gate frame. The stems of the hydraulic cylinders are connected to toggle mechanisms that operate the movable wedges in such a way that overtravel of the stems, induced by the introduction of water pressure on the top of the cylinders, will cause the toggles to force the wedges downward. Both the stationary and the movable wedges are constructed of cast steel and have a taper of ¾in. per foot. A corner filler is placed in each lower corner of the gate recess to keep rocks or other obstructions from accumulating at these points, and thus interfering with the complete closing of the gate. This filler consists in the main of three reinforced concrete slabs laid on a filling of clean sand. The slabs are locked in position and will be removed, when desired, by releasing the locks and pulling the slabs upward and outward from their seats with the aid of wire ropes attached to the slabs. The sand will then be driven out of the recess by two jet pipes. Cooling sprays will reduce the temperature of the metal in the gate to approximate equality with that of the river water before the gate is lowered. The spray system, in each case, is made up of three 1¼in. pipe lines; one line is placed horizontally above the gate, with the jet set to spray the gate on the tunnel side, and the two other lines run vertically within the gate, between the upstream cover plate and the skin plate. It is estimated that the total amount of water required for lowering the gate will be about 98,000 gallons, and that the maximum supply required at any time will be 660 gallons per minute. The cylinders can be filled in seventy-five minutes and the gates lowered in forty-five minutes. Each gate will be sealed in position by a rubber and a bronze seal at the downstream side and at the top of the gate, and by a babbitted seal at the base. Each bulkhead gate weighs 2,180,000 lb,. while the weight of a gate, hydraulic cylinders, wedges, and steel frame totals 3,065,000 lb.

Exclusive of erection charges, the cost of the two Stoney gates, with their frames and hoists, was about 64,000 dollars, while the bulkhead gates, with their related features, involved an outlay of about 266,000 dollars. The materials and parts of each bulkhead gate required the services of forty-two railway cars to transport them to Black Canyon.

PERSONNEL.

The numerical peak of employment was reached on January 1st of the present year, when a total of 3882 men were directly engaged on the different phases of the work at and adjacent to the dam site. From now onwards this army will diminish gradually, but the proportion of expert workers will increase because of the higher order of work that will be in progress in many departments of the undertaking. While various other parts of the task are under way, very few of them have advanced beyond their initial stages, and, such being the case, we shall not refer to them until they have proceeded far enough to make them noteworthy.

The Institution of Electrical Engineers.

THE PRESIDENTIAL ADDRESS.

THE present position of power cable manufacture and the prospects of its future development formed the outstanding subject of Mr. P. V. Hunter's Presidential Address, delivered before the Institution of Electrical Engineers on Thursday, October 26th. Attention was also paid, however, to matters of current interest, including the proposal that small distribution systems should be absorbed by the larger undertakings. While giving support to this idea, Mr. Hunter admitted that it was difficult to show that the present arrangement had resulted in any appreciable addition to the cost of electricity. The situation, he said, was entirely different from that which existed in connection with the generation of electricity before the advent of the "grid." Under those conditions, large sums were wasted in the building of small and uneconomical generating stations, but no waste of that nature occurred in connection with distribution.

Even the smallest authorised undertakings had adopted the three-phase, four-wire system for general low-voltage distribution, and so far as distribution capital expenditure was concerned, the size of the undertaking had little or no effect. Similarly, the energy lost, the expenditure on repairs and maintenance, and the sums to be paid annually for rates and taxes were substantially the same in both cases. Those items comprised by far the major portion of the total annual cost of distribution and the economies possible in the operation of large, as against small distribution systems were confined to management expenses which might generally be assumed to be less than 20 per cent. of the total cost. But these considerations were not put forward as an argument against the consolidation of distribution areas. The broad view that small distribution systems should be absorbed in the larger organisations was, in Mr. Hunter's opinion, undoubtedly correct, although he made little attempt to develop the argument. It was satisfactory to realise, he explained, that where the process was delayed, there would not be an accumulation of wasteful capital which would ultimately have to be made good. The most interesting part of the address from a technical point of view was that devoted to cables, of which the following is an abstract.

It will be convenient first to consider present-day British practice in the ordinary type of solid impregnated paper cable, which is now employed for working pressures up to and including 66-kV three-phase. An outstanding fact that has been brought out by practical experience is the superior performance of the screened type of cable, as compared with the belted type when subjected in service to high working stresses in the dielectric. Two sets of graphs—Fig. 1—have therefore been prepared, showing the maximum working stress of the belted and screened types of cable for pressures up to 66 kV. For the purpose of these curves the dimensions of the British Standard Specification No. 480 have been employed where applicable, *i.e.*, for voltages up to and including 20 kV. For voltages above this limit, although there are no standards which have been adopted by the British Standards Institution, the current accepted practice of the Cable Makers' Association has been followed, which provides for a dielectric thickness of 0·325in. for 33-kV cables and 0·65in. for 66-kV cables. It is at once apparent from Fig. 1 that for no obvious reason there are considerable differences in the stresses for the different voltages. There is no technical justification for working a 0·25 square inch 11-kV screened cable at the low maximum stress of 22·5 kV per centimetre, when for the same size of conductor in a 66-kV screened cable the dielectric is subjected to the much higher stress of 42·2 kV per centimetre.

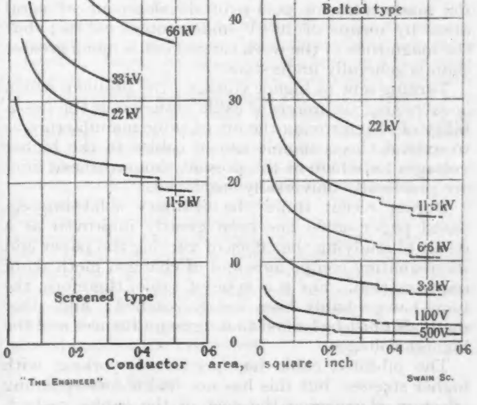


FIG. 1—MAXIMUM WORKING STRESSES OF 3-CORE CABLES

In order to see whether these higher working stresses are permissible in the lower voltage cables, two separate trials have been made, in which lengths of cable having 22-kV dimensions have been manufactured according to the methods employed in the case of 66-kV cables, and using similar materials. The resultant quality of the insulation is therefore equal to that of the 66-kV cable. The cables so made have been put to work in 33-kV systems, with satisfactory results. The maximum stress in these cables when working was 51·5 kV per centimetre, which, it will be noted from Fig. 1, is higher than that ordinarily experienced by a 66-kV cable. It may be concluded, therefore, that there is a margin for economy obtainable in the lower-voltage cables by so reducing the thickness of dielectric as to give the same working stresses as in the higher-voltage cables. Before this can be achieved, however, complete confidence must be established in commercial working at the higher stresses.

Cables are expected to have a lengthy economic life, and changes in accepted practice can be justified only by convincing evidence in favour of the alteration. Moreover, the most ardent advocate of reducing the dimensions of lower-voltage cables is apt to be discouraged when viewing the results in true economic perspective. Under the conditions in which these cables are normally laid in the streets of cities and towns, the cost of trench work is a high proportion of the total, and even a substantial reduction in the dielectric thickness of low-voltage cables has but a small effect when expressed as a percentage of the total cost of the laid cable.

There are, however, conditions in which an economy in cable manufacture would be of considerable economic value, namely, in the case of 11-kV cables for rural distribution laid across country. Under these conditions the cost of the trench work can be kept much lower, and the economies in the cost of the cable itself represent a higher proportion of the total cost. The employment of underground cables for rural work in this country is inclined to languish, partly because up to the present time engineers have been reluctant to run cables across country in the same way as they do overhead lines. There is, however, no real objection to such methods. The cable is less liable to interference and less costly to maintain than when laid in public roads.

It should also be possible to standardise a universal type of rural cable for 11-kV working, of fixed conductor size and special design, working at the stresses permitted in super-tension cables. If this were done, not only would the cable be intrinsically cheaper to manufacture, but economy would result in many directions. For instance, at the present time, owing to the multiplicity of sizes and types, the average length of 11-kV cable put through a factory on each order is less than 1 mile.

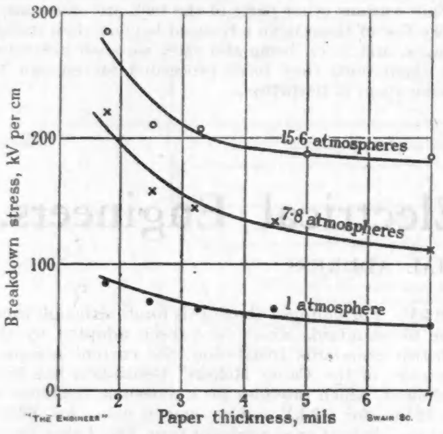


FIG. 2—RELATION BETWEEN PAPER THICKNESS AND BREAKDOWN STRESS

It is well known that in Holland there has existed for many years a policy of development of rural areas by means of 10-kV underground cables; but the magnitude of the work carried out is much greater than is generally understood.

Turning now to higher voltages, the problem which is exercising the minds of cable designers is the possibility of so improving the art of cable manufacture as to extend the economic use of cables to the higher voltages for which at the present time overhead lines are practically universally employed.

During recent times the ordinary solid impregnated paper cable has been greatly improved as a result of studying the effect of varying the paper and impregnating compounds and of changed methods of impregnation. For this type of cable, therefore, the limit has probably been nearly reached; and other methods must be looked to for great advances and the highest voltages.

The oil-filled cable has permitted working with higher stresses, but this has not had a corresponding effect in cheapening the cost of the cables as laid. Some radical departure from existing methods is therefore necessary. Physicists have not so far produced any generally accepted fundamental theory explaining the mechanism of insulation and the *modus operandi* of dielectrics under electrical stress, so that we cannot say what are the limiting possibilities.

It has long been known that the electric strength of gases increases with compression, and in a paper* read before this Institution in 1909 E. A. Watson showed the use of compressed air in reducing the dimensions of a static voltmeter. Also, in the year 1915, F. Kock described in the *Elektrotechnische Zeitschrift* the results of experiments showing the increased breakdown strength resulting from the compression of a number of materials, including transformer oil. It is not possible to make cable dielectrics exclusively of either gases or oils under compression; but, using paper as a supporting medium, both these methods have been under investigation by a number of workers.

The results obtained by submitting a solid impregnated-paper cable to compression have been published by Höchstädter, who found that by raising the compression from 1 atmosphere to 16 atmospheres the long-time breakdown strength was increased by 100 per cent. By this method a 66-kV cable is made suitable for 132 kV, which is a very considerable advance; but even this is hardly sufficient to make underground cables competitive with overhead work as regards their capital cost, after taking account of the cost of the additional equipment. The practical development by Emanueli of the oil-filled cable in the form in which it is generally used aims at controlling the internal pressures set up within the cable by changes of temperature consequent on load variations. The pressure variations permitted by his design lie within the range of 1 atmosphere minimum to about 4 atmospheres maximum. Even with this range he finds it necessary, in general, to reinforce the cable sheath, the usual practice being to provide two lead sheaths with a brass reinforcing tape enclosed between them. It wouldnot be difficult to adapt such a system to work with much higher oil pressures; for instance, a range of pressure from 4 to 7 atmospheres would involve very little modification to the construction of the cable itself, although the design of the joints and terminals would undoubtedly be rendered more difficult.

The methods of sheath reinforcement necessary to withstand the higher pressures employed in such circumstances and with the compressed gas cable referred to later have received some attention, with the surprising result that paper has been found to be the most efficient material for this purpose in circumstances under which ferrous metals may not be used. In their endeavour to produce a paper to take the place of woven fabrics in mechanical applications papermakers have successfully evolved a comparatively cheap wood pulp paper in which the breaking strain is 18,000 lb. per square inch, thereby rendering it more economic than a non-ferrous metal. There is no objection to the use of paper when it is enclosed and hermetically sealed in the annular space between two lead sheaths, and from the point of view of ease of handling and mechanical considerations generally paper is preferable to metal tapes, which, in order to make them workable, have to be enclosed in a bedding of some softer material. In America C. E. Bennett has developed a system in which oil-filled cables without lead sheaths are installed in an oil-filled steel pipe. The gain in electrical strength of such a system will be much the same as that of the Höchstädter gas compression method just described, and the economic comparison of the two systems will lie more particularly in differences of capital cost and thermal conductivity.

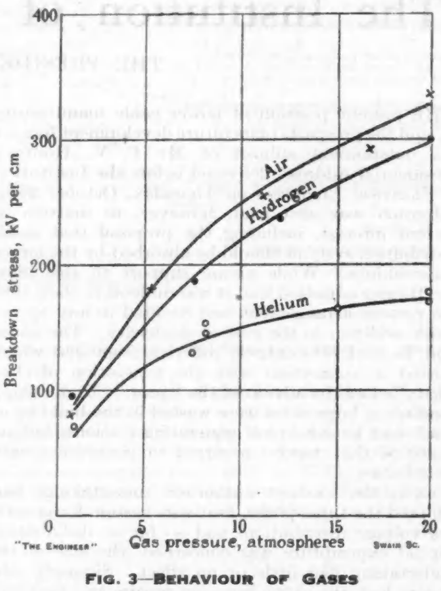


FIG. 3—BEHAVIOUR OF GASES

The gas pressure cable, so called, is one employing in the paper structure gas or gases as both the impregnating and the pressure medium. It presents to investigators an involved problem, as different gases vary in electrical strength, and also in thermal conductivity; and the thickness and density of the paper employed have also a material effect on the electric strength of the cable. Fig. 2 shows the relation between paper thickness and breakdown stress, where compressed nitrogen is used as the filling medium.

The behaviour of different gases is illustrated in Fig. 3, which shows the relation between gas pressure and breakdown stress for air, hydrogen, and helium when used in association with thin Manila paper. Investigation has also been made to determine the effect of a mixture of gases, and an interesting case is that of air and helium—Fig. 4. It will be noted that the poor electric strength of helium is rapidly improved by small additions of air. In this case also thin Manila paper is used with the gases. These results show that it is possible to obtain an increase of from 200 to 300 per cent. in the electrical breakdown strength by raising the compression of the gas used as a filling medium, and by selection of the thickness and density of the paper used a further considerable increase in strength is obtainable.

The discriminating utilisation of these phenomena clearly offers the possibility of producing cables of economical dimensions for the highest voltages. It is in fact doubtful whether breakdown strength will remain the determining factor for the thickness of the dielectric, since at these high voltages the use of a very thin dielectric would give rise to a large capacity current, notwithstanding the fact that the gas pressure cable has a lower specific inductive capacity than the ordinary impregnated cable. Another variable entering into the economic design of a successful cable is the thermal resistance of the dielectric. Helium, for instance, which has a high thermal conductivity, has an indifferent breakdown strength.

C. J. Beaver has suggested that the thermal conductivity of gas pressure cables may be improved by pre-impregnating the paper, and the problem then resolves itself into one of producing a pre-impregnated paper having a good thermal conductivity and also a good power factor. He has also proposed to exhaust the cable instead of filling it with compressed gas, but the vacua required are of a very high order considered from the point of view of commercial operation and possible leakages. It is clear, however, that there are a large number of possible variants; in fact, the difficulty appears to lie in correctly estimating the effect of a number of variables so as to arrive at the best economic design of cable. It seems probable that the resultant cable will require some measure of compensation for capacity current when operating at 132 kV and more, and a convenient method of overcoming the difficulty seems to be that of increasing the magnetising current of step-down transformers.

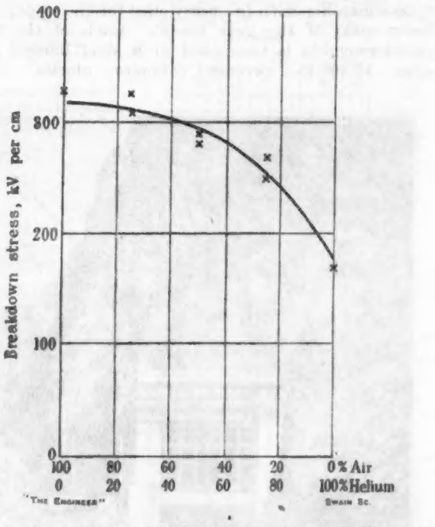


FIG. 4—EFFECT OF ADDITION OF AIR TO HELIUM

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ENGINEER-CAPTAIN H. B. TOSTEVIN, D.S.O., R.N., has been appointed chief engineer of the marine department of the Vacuum Oil Company, in succession to Mr. A. H. Mather, who retired on pension at the end of September, after twenty-eight years' service with the company. He took up his new duties on November 1st.

THE Governors of the Borough Polytechnic have appointed Dr. D. H. Ingall as Principal of the Borough Polytechnic, in succession to Mr. J. W. Bispham, who has been promoted to Assistant Education Officer (Technology) under the London County Council. Dr. Ingall took up his duties on Monday, October 23rd, 1933.

IT was officially announced at a luncheon of the British Electrical Development Association, held at the Savoy Hotel, on Friday, October 27th, that Sir William Ray, M.P. for Richmond, Chairman of the Local Government Economies Committee and leader of the London County Council, has been appointed Chairman of the Association.

MR. ALAN MONCRIEFF, M.C., M.A., A.M. Inst. C.E., M.I. Struct. E., M.I.E. (India), is carrying on the practice of the late firm of J. Mitchell Moncrieff and Partners, consulting engineers, of Westminster and Newcastle-on-Tyne, at 25, Victoria-street, (South Block), Westminster, S.W.1 (telephone, Victoria 9453). The goodwill and all records of the firm, in which he was a partner for some years, have been left to him by his father, the late Colonel J. Mitchell Moncrieff.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY announces that, by virtue of an agreement with the Internationale Benson-Patentverwertungs-A.G., in Zurich, it has obtained patent and manufacturing rights for the United States of the "Benson" boiler. In the manufacture of the boiler the Westinghouse Company will work in collaboration with Messrs. Siemens-Schuckert in Berlin for land boilers, and with Blohm and Voss in Hamburg for ship boilers.

THE INSTITUTION OF CHEMICAL ENGINEERS.—The application forms for the examination for the associate membership for 1934 of the Institution of Chemical Engineers are now ready. These forms are returnable on December 20th, 1933. Application forms and copy of the memorandum on "The Training of a Chemical Engineer" may be obtained from the Hon. Registrar, Institution of Chemical Engineers, Abbey House, Westminster, S.W.1.

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* *Journal, I.E.E.*, 1909, Vol. 43, p. 113.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Brighter Conditions.

There has been a definite improvement in the tone of the iron and steel markets, probably owing to the placing of a number of contracts for export and the assurance of fresh business coming on the market in the near future. Some of the new contracts have already been referred to in these columns, and, in addition, the shipbuilders in this country anticipate securing contracts for building some of the vessels included in the Brazilian Government's naval programme, which is said to provide for twenty-six warships, including two battle-cruisers, a destroyer flotilla, and submarines. The British railways have also announced programmes which will be a considerable help to the iron and steel makers, just as the mills employed on railway material were beginning to get short of orders. The London and North-Eastern Company has announced that it will enter upon a programme of work involving the expenditure of £2,300,000, which will include the construction of one hundred locomotives, many carriages and wagons, and also the renewal of forty-three bridges and 370 miles of line. On the Continent also some improvement has been noticeable. For some time past there have been reports that the Continental Steel Cartel intended to advance its prices. The situation, however, has been so unfavourable that little attention has been paid to these statements. Over the week-end, however, the rumours grew stronger, and some of the Continental works withdrew their prices. The net result, however, of the Cartel's deliberations was that their c.i.f. quotations for South America were advanced by 2s. to 2s. 6d. gold. It is stated that the c.i.f. prices for India and Japan are to be reviewed, and the quotation for China also has been increased by 2s. gold. As generally happens before a price advance takes place, there was a certain amount of buying by merchants who were able to place contracts before the new quotations became effective. It may be supposed, therefore, that there is at hand another period in which a few fortunate merchant firms will be able to underquote the works official quotations, just as they were able to during the early part of the summer. It is interesting to note that the quotations for the British market are to remain unchanged.

Tube Trade Arrangements.

Interest attaches to the news that the Japanese tube manufacturers have joined the International Tube Association, principally, it is said, as a result of the negotiations which have been conducted by the French Tube Association. The Continental tube makers are closely associated in the International Tube Association with the firms remaining in the British Tube Association and with the American and Canadian manufacturers. There are, however, a number of British tube makers outside the organisation, although for some time negotiations have been proceeding with the object of bringing them into the British Tube Association and into the International Cartel. In these circumstances the agreement with Japan may be regarded as a successful move. It is understood that the Japanese home and colonial markets and the Manchurian market are to be left to the Japanese makers, whilst the other makers in the International Tube Association will deliver certain descriptions of tubes when the market requirements exceed certain prescribed limits. The Japanese makers, however, will adhere to a scale of prices agreed upon by the Tube Association. The agreement extends until 1937, and is expected considerably to reduce the competition for orders which has been going on in the Far Eastern markets. It is interesting to note that the Japanese attempted to invade the British home market, but without much success. The independent British firms and the Swedish makers are not, of course, parties to the new arrangement, but negotiations are taking place with the Swedish makers with a view to bringing them into the International Cartel. If these discussions and the efforts to induce the independent British works to join the British Tube Association are successful the tube industries of the world will be effectively "cartelised."

The Pig Iron Market.

THIS department of the iron and steel trades continues to gather strength. The lull in demand noticed a short time ago, which followed the placing of a number of large contracts for delivery into next year, has passed, and the position is steadily turning in favour of the producers. The stocks which were overshadowing the market are being cleared, and the prospect of prices being advanced owing to the increased cost of coke and ore is causing consumers some anxiety, especially as the ironmasters are not anxious to sell forward at current rates. During the past few weeks the quotation of best Rubio ore has increased from 15s. 6d. to 16s. 6d. per ton, and good Durham blast-furnace coke has advanced from 16s. 6d. to 17s. 6d. d/d furnaces. The market apparently expects higher prices for pig iron; but seems to anticipate an increase in zone prices rather than a general upward movement. The demand for Cleveland iron has expanded, although some relief has been afforded the market by the transference of a furnace from basic to foundry pig iron. It is also expected that another furnace will be started upon foundry iron in the course of a week or two. The situation in this market, however, remains rather tight, and consumers are showing more willingness to buy for next year's delivery than the producers to sell. The Midland ironmasters are not in so strong a position as the Cleveland makers, but the situation in that district has taken a distinct turn for the better. Buying has been confined for the most part to small parcels, but the total tonnage has increased over the past fortnight. The volume of current buying, however, is stated to be sufficient to absorb the production and to call for withdrawals from stock. Similar conditions exist in Lancashire, but the tone of this market has appreciably improved. The light casting foundries producing builders' materials are taking good quantities of iron and a welcome increase in the requirements of the heavy engineering trades is reported. The demand for Scottish irons, both in Scotland and in the English consuming districts, is steady, but does not show any signs of increasing. Some of the Scotch engineering works are taking rather larger deliveries than for some time past. The producers of hematite have at last reached an agreement on prices, which have been advanced 2s. 6d. to home consumers, making the quotation 62s. 6d. for mixed numbers and 63s. for No. 1. The export price is unchanged at 60s. f.o.b. for mixed numbers and 60s. 6d. for No. 1.

Semi-finished Steel.

The chief characteristic of this market is the strong demand for billets and the activity at the British works which are producing this class of material. Business in sheet bars has not been so brisk as in billets, but it seems to be expanding. The busy conditions at the re-rolling works are, of course, responsible for the position in these departments. In the Midlands the quotation for sheet bars, which has been nominally £5 delivered for some time, has advanced to £5 2s. 6d. to £5 5s. For billets also the price is firm at £5 5s. for 500-ton lots and up, ranging to £5 10s. for smaller quantities. Some of the Midland producers are behindhand with deliveries and in some cases have declined to quote for delivery until early next year. There seems to be little to choose between the conditions in the various districts in Great Britain. The works on the North-East Coast, in Scotland, and in Wales are equally busy. The somewhat tight conditions which have developed in this market have encouraged the Continental producers to take a firmer attitude with regard to prices, and a certain amount of business has been transacted at rates which are practically the same as those quoted for British material. In the Midlands Continental 2in. billets have been sold at £5 5s., but it is probable that the Continental works would not let an attractive order pass if it could be obtained by cutting this figure. Apart from occasions when Thomas steel billets are specially required, consumers would prefer to place orders with British producers if the Continental quotation is within a few shillings of the home price, as normally the terms of delivery and payment are more satisfactory. In the present state of the market, however, a number of the re-rollers have thought it wise to take precautions against a possible stringency or fresh advances in price.

Finished Steel Materials.

The general situation has not altered much in the finished steel department, excepting that some encouragement has been given the export side of the market by the Dutch contracts referred to last week and by some orders from China. The latter business is allocated from the Boxer Indemnity Fund, and is for 4000 tons of 60 lb. rails, and constructional steel for bridges. In addition, tenders are to be invited for four 2000-ton boats. It is estimated that the rail and steel contracts will amount in value to £150,000. The home market, however, continues to be the mainstay of the steel works, and the demand is well sustained. The North-East Coast works are busy on constructional steel material, but the rail mills are not so well off for work. The black sheet makers are moderately busy, and although the poor request for shipbuilding steel is still the weak spot, the general position is gradually improving. The Midland steelmakers complain of the light business they are doing in joists and sections, but during the past week the demand has shown signs of increasing. More orders have been booked, and although the constructional engineers refuse to be tempted into placing good-sized contracts, the aggregate tonnage is beginning to grow larger. A satisfactory feature of the situation is the appearance of the colliery companies on the market. The demand from this source has been disappointing this season, but orders amounting to a good tonnage have been placed recently, although the total quantity bought is below the normal for the time of year. The market for small bars is fairly active, and the steel makers producing their own material now ask £7 to £7 5s. for small bars. Re-rollers quote £6 17s. 6d. to £7, but some of them do not let Continental sellers take a good order for the sake of 2s. 6d., and as a result most of the current business is retained in this country, even though Continental merchant bars can be obtained at less than £6 10s., including duty. In South Wales the tin-plate works are operating at over 60 per cent. of capacity, and are keeping their sales ahead of production. Their prices have become firmer at 17s. to 17s. 3d. per standard box.

Scotland, Lancashire, and Yorks.

The recent improvement in business in the Scottish iron and steel markets has been maintained. Most branches of the industry are better employed than for some time. There is, of course, a proportion of unemployed plant, but the general tone of the market is optimistic, and as the season advances business appears to be expanding. The ship repairers are fairly busy, but the call for shipbuilding steel is below normal. There are, however, expectations that fresh shipbuilding contracts will be placed, which would mean more work for the steel mills. Great hopes are entertained that Scottish firms will be successful in tendering for the two new vessels for the Blue Star Line. Some firms report a better inquiry on export account, but only a proportion of this has developed into actual business, and it is difficult to discern any real improvement in the demand from overseas markets. Business in re-rolled material is on the quiet side, and it is in this department the slight improvement in export business is noticeable. Conditions in Lancashire are satisfactory on the whole. Business is particularly good in alloy and special steels, and the demand which has been fair for several weeks past seems to be expanding. There is considerable irregularity in the requirements of the constructional engineers. Some of the local firms are well employed, but others, having completed contracts, are rather badly placed as regards work. An encouraging feature of recent business is that the tonnage of new orders shows a tendency to increase. On the North-West Coast a fairly good flow of business is being experienced, but, as in other districts, the rail mills are beginning to get short of work. Steel makers in the Sheffield district are more optimistic than for a long time. Business in most branches is either steady or expanding. Special steel makers are comfortably off for orders and most of the rolling mills are working full time, whilst the manufacturers of stainless steel are experiencing something in the nature of a small boom.

The Copper Market.

The electrolytic copper market has been largely under the influence of developments in the United States. No one is prepared to prophesy as to the outcome of the American Administration's latest policy of buying gold, and the resulting lack of confidence has been acutely felt in the copper market. Prices have been weaker without any definite reason beyond the uncertainty ruling in all departments of the market and the nervousness displayed by consumers. There has been a certain amount of buying by American and Continental interests as a hedge against currency depreciation, but so complete is the mystification of business men as to the outcome of the American policy that even this has not been on an important scale. The American domestic price has been held at 8½ c., but the export price which had decreased to 8 c., receded slightly to 7.90 c. to 7.95 c., although the movements of the dollar exchange have caused the sterling price to move between £37 and £37 10s. There has been less inclination on the part of American Customs smelters to press sales, and this has helped to check a break in quotations. In Europe consumers are by no means well covered, but at the same time they hesitate to buy important quantities. The German market has been rather active as a result of the German Government's public works programme, but buying from other Continental countries has been restricted to comparatively small quantities. The London standard market has a fairly healthy appearance since the break in prices last week resulted in the liquidation of some rather weak accounts. The sales, however, were easily absorbed, and the undertone of the market is sound, although in common with other metal markets prices have shown a tendency to decline. Apparently there is only a small speculative account open, and operators are displaying a strong inclination to mark time.

The Tin Market.

The event of the week in this market was the announcement by the International Tin Committee that a new agreement regulating output and exports for a further period of three years was signed on October 27th. The new agreement follows the lines which the market has anticipated for some months. The export quotas have been increased from 33⅓ per cent. to 40 per cent. of the standard tonnage, and for 1934 an additional 4 per cent. quota has been agreed to. The agreed standard tonnages are:—Bolivia, 46,490 tons; the Malay States, 71,940 tons; the Dutch East Indies, 36,330 tons; and Nigeria, 10,890 tons; whilst Siam has been given a quota of 9800 tons. The announcement had little effect upon the market, although there was some liquidation which was easily absorbed. Buying by consumers has been on a poor scale. American dealers and consumers have shown practically no interest in the market, whilst Continental buyers have been content to limit their purchases to almost retail quantities. British users, also, have bought sparingly, but the South Wales tin-plate works have continued to take their normal supplies. In the face of these rather poor trading conditions, the market has shown strong powers of resistance to depressing influences. The good statistical position is probably responsible for this, although some disappointment was occasioned by the failure of the International Tin Committee to publish details of its holdings. It was known that the Pool held 21,000 tons of tin for a considerable period, and although it is supposed that a good proportion of this was released during the summer "boom" in this market, dealers would be relieved if the present position was made clear.

Lead and Spelter.

The easier tone in the lead market this week must be attributed to the business uncertainty which has developed since President Roosevelt embarked upon his new monetary policy. There has been no fundamental change in the position, and although stocks are heavy, they are probably not increasing, and in the United States there has been a definite decrease. Buying by consumers has not been active of late, but the lead pipe and sheet makers continue to use good quantities and to provide a steady outlet for the metal. The American price has been increased as a result probably of the depreciation of the dollar, but this has had little influence upon the London market. The Continental consumption of the metal is said to be on a good scale. . . . In the spelter market also prices have reacted without any definite change in the situation to warrant the movement. Business in this metal has been quiet, and the demand from the galvanising trade, which has been light for some time, does not look like improving at the moment, since most of the galvanised sheet makers are short of orders. Probably the demand is just about sufficient to take care of the production. Notwithstanding the weakness in prices, this market seems to be in a healthy condition, and it is probable that any change in sentiment regarding the American position would be quickly reflected in higher prices.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— *(D/d Teesside Area)*		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
Midlands—		
Staffs.— *(Delivered to Black Country Station)*		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ $\frac{5}{16}$in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ $\frac{3}{16}$in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in.	8 15 0	7 15 0
„ $\frac{5}{16}$in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ $\frac{3}{16}$in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ $\frac{5}{16}$in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ $\frac{3}{16}$in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL *(continued)*

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ $\frac{5}{16}$in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ $\frac{3}{16}$in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ $\frac{5}{16}$in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ $\frac{3}{16}$in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ $\frac{5}{16}$in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ $\frac{3}{16}$in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 17/-.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	5 15 0
„ Medium (0·42% to 0·60% C.)	6 12 6
„ Hard (0·61% to 0·85% C.)	7 2 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 25% C.), 500 tons and up	5 2 6
100 tons	5 10 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/7 per lb.	
Ferro Tungsten	2/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 17 6	7/-
„ „ 6 p.c. to 8 p.c.	£19 7 6	7/-
„ „ 8 p.c. to 10 p.c.	£18 17 6	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£29 15 0	9/-
„ „ „ 1 p.c. carbon	£30 17 6	10/-
„ „ „ 0·70 p.c. carbon	£35 15 0	12/6
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£18 2 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, November 1st.

	Home.	Export.
Copper—		
Cash	£32 13 9 to £32 15 0	
Three months	£32 16 3 to £32 17 6	
Electrolytic	£36 0 0 to £37 0 0	
Best Selected Ingots, d/d Birmingham	£36 15 0	
Sheets, Hot Rolled	£64 0 0	
Tubes, Solid Drawn (basis)	10¼d.	10¼d.
„ Brazed (basis)	10¼d.	10¼d.
Brass—		
Ingots, 70/30, d/d Birmingham	£33 0 0 to £35 0 0	
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£224 7 6 to £224 12 6	
Three months	£224 2 6 to £224 7 6	
Lead:	£11 13 9 to £12 1 3	
Spelter:	£15 11 3 to £15 18 9	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 13/-
„ Glasgow— Ell	12/6 to 14/-
„ „ Splint	14/9 to 15/-
Ayrshire—	
(f.o.b. Ports)—Steam	12/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/6 to 14/-
Unscreened Navigation	12/3 to 13/-
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/- to 13/6
Secondary Steam	13/-

ENGLAND.

	Inland.	Export.
Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/6 to 20/6
Furnace Coke		13/- to 17/6
Northumberland—		
Best Steams		13/9 to 14/-
Second Steams		12/9 to 13/-
Steam Smalls		10/-
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/6
Foundry Coke		17/- to 18/6
Sheffield—		
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	22/- to 24/-	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	8/- to 9/-	—
Nutty Slacks	7/- to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	18/3 to 18/6
Best Steam Smalls	13/6 to 14/-
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 27/-
Foundry Coke	19/- to 36/-
Furnace Coke	16/- to 17/6
Patent Fuel	19/6 to 21/-
Swansea—	
Anthracite Coals:	
Best Large	35/- to 38/6
Machine-made Cobbles	35/- to 48/6
Nuts	37/6 to 48/6
Beans	25/- to 30/-
Peas	18/- to 20/6
Rubbly Culm	10/- to 11/-
Steam Coals:	
Large	18/- to 20/6
Nuts	18/- to 25/-
Smalls	11/- to 13/-

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3¼d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

An Industrial Deadlock.

THE industrial situation is relieved of the menace that overshadowed it as the result of the measures incorporated in the Budget proposals, whereby the Government would have embarked definitely upon the scheme of industrial nationalisation by monopolising the manufacture of war material and firearms, and would have imposed the forty hours' week, without wages reduction, on those makers executing orders under the programme of public works, besides putting further taxes on profits and an exorbitant tax on petrol for motor cars. The Budget proposals were rejected independently of any question of industrial interest, but so violent was the opposition throughout the country to anything being done to interfere with the normal development of trade and industry that the Socialist efforts may be said to have failed beyond hope of recovery. The warnings of exporting industries that the present policy of trade restrictions will inevitably lead to industrial collapse are strengthened by the measures of retaliation adopted by some countries, notably the decree just put into operation by Brazil prohibiting the importation of goods from France except by special licence of the Minister of Finance, whose permission will also be required for a transfer of funds from Brazil to France. These measures are reprisals against restrictions imposed by the French Government on the importation of Brazilian products and against a recent financial decree instituting a system of compensation for debts between the two countries. There are also difficulties with Spain, Portugal, and other countries. The exporting industries insist that the new Government must avoid additional taxation by realising economies in the State administration and carry out immediately negotiations with foreign countries for commercial agreements which will enable them to recover some of their export trade.

The Railway Disaster.

The disaster to the fast express from Cherbourg to Paris on Tuesday morning of last week, when thirty-eight lives were lost and many persons were seriously injured, has raised the question whether the weights and speeds of trains have not reached the limit which the track will bear. The train was a heavy one, hauled by a locomotive of the "Mountain" type, the same as that in service on the Est Railway, where, it is remarked, a similar accident occurred recently, though of a much less serious character and without injury to anyone. At the place where the locomotive was derailed while travelling at 68 miles an hour, a gang had been packing ballast under sleepers in the ordinary course of track maintenance, and it had not been regarded as necessary to put up caution signals against advancing trains. The State Railways affirm that the track cannot be blamed. It is declared by witnesses that the locomotive was rocking dangerously before entering this section, and that it turned over down the shallow embankment at the moment when the brakes were applied. The rails were bent and twisted, and the three first coaches of wood which fell with the locomotive were smashed completely. There is a natural tendency to attribute the accident to a weakening of the permanent way by the operations of the gang, but the alleged behaviour of the locomotive before entering that section of the line complicates an official inquiry which is still proceeding.

Naval Construction.

Whatever economies may have to be effected in State services there is no intention to make cuts in the expenditure on the Navy. While the Estimates for the present year were reduced to aid the Budget as a temporary expedient, the late Minister of Marine declared that the programme of construction would continue normally in 1934, and the fact that the new Premier, Monsieur Sarraut, who succeeded the late Monsieur Georges Leygues, will continue his office as Minister of Marine, indicates the importance he attaches to continuity in the work of building up a strong fleet. It is rather unusual that a public statement should be made of the progress made in naval shipbuilding, and of the performances accomplished by ships recently launched. In the same communication it is affirmed that vessels to leave the stocks shortly will be the 7500-ton cruiser "La Galissonnière" at Brest and two destroyers of 2400 tons, while the cruiser "Jean-de-Vienne" will be launched at Lorient in 1934, and the three cruisers "Marseillaise," "Gloire," and "Georges Leygues," will be laid down at the end of the year. Of the twelve convoys to be built, orders have been given out for ten. Eleven torpedo-boat scouts have been completed, or are nearly ready to be delivered by private builders. These small boats are of various types, some of them in the form of very fast motor boats designed and equipped for launching torpedoes.

Trade with British Dominions.

For the first time the amount of business done with British Dominions is detailed separately in the trade returns issued for the first nine months of the year, instead of being lumped up together amongst "Other foreign countries." So far as Great Britain is concerned, the imports into France totalled 1656 million francs, as against 1821 millions in the similar period of 1932, and the export of French goods and produce to Great Britain amounted to 1191 million francs, as compared with 1486 millions. The imports into France from Canada, totalling 224 million francs, were less than one-half of those for the previous year, and French exports to Canada dropped from 131 million francs to 79 millions. The imports from Australia amounted to 511 million francs, and the French exports to that Dominion were valued at 50 millions. The exports to the Irish Free State were valued at 12,903,000f., and the imports from that country at 7,320,000f. South Africa supplied France with goods to the value of 240 million francs, and took in return French products valued at 33 million francs. The Dominions supply France with raw materials and produce and receive essentially French goods with little in the nature of engineering products.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

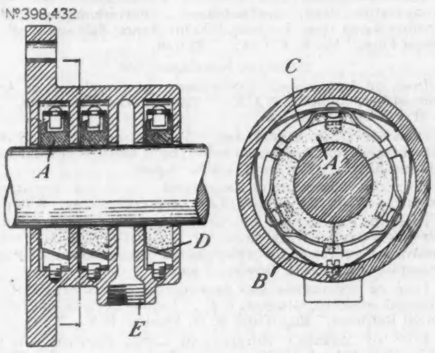
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

398,432. March 22nd, 1933.—SHAFT PACKINGS, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

In this packing the graphite blocks A are held up, each in their separate chambers, to the shaft by the springs B bearing against the metal backing pieces C. The blocks and their backings are cut at an angle, as is shown at D, so that there is a bias for the blocks to bear against the side walls of the chambers and thus ensure an effective seal. A drain is provided at E.—*September 14th*, 1933.

Nº398,432

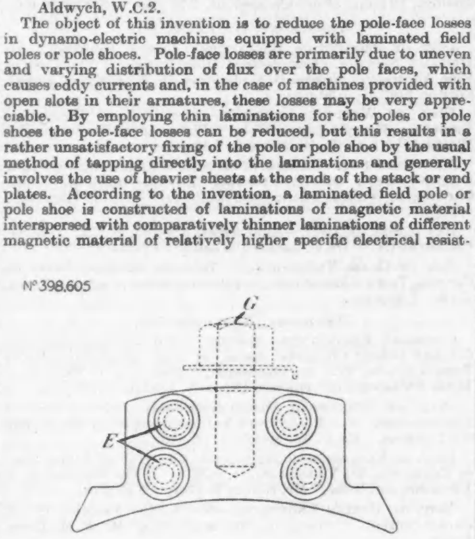


DYNAMOS AND MOTORS.

398,605. May 30th, 1932.—DYNAMO-ELECTRIC MACHINES, Arnold Tustin, of 22, Glentilt-road, Sheffield, York; and Associated Electrical Industries, Ltd., of Crown House, Aldwych, W.C.2.

The object of this invention is to reduce the pole-face losses in dynamo-electric machines equipped with laminated field poles or pole shoes. Pole-face losses are primarily due to uneven and varying distribution of flux over the pole faces, which causes eddy currents and, in the case of machines provided with open slots in their armatures, these losses may be very appreciable. By employing thin laminations for the poles or pole shoes the pole-face losses can be reduced, but this results in a rather unsatisfactory fixing of the pole or pole shoe by the usual method of tapping directly into the laminations and generally involves the use of heavier sheets at the ends of the stack or end plates. According to the invention, a laminated field pole or pole shoe is constructed of laminations of magnetic material interspersed with comparatively thinner laminations of different magnetic material of relatively higher specific electrical resistance than the first-mentioned magnetic material. The field pole illustrated is about 12in. long and 2in. deep and comprises an assembly of laminations of black sheet steel, 0·065in. thick, and laminations of what is commonly known as electric sheet steel, being a silicon steel alloy having a relatively much higher specific electrical resistance than the black sheet steel and 0·014in. thick. In the drawing the ordinary sized laminations are designated A and the special thinner laminations B. The thick and thin laminations are disposed alternately throughout practically the whole length of the field pole and at each end of the field pole there is a packet C of the ordinary laminations, 0·065in. thick, these laminations being spot welded together to serve as rigid end plates for the structure. The assembled laminated structure is longitudinally bored at D to accommodate fixing rivets. As usual, these rivets are in the form of bars, the ends of which are drilled and subsequently flared after insertion in the bores, as shown at E. The laminated structure is also provided with tapped holes F adapted to receive the studs G whereby it is fixed to the yoke of the dynamo-electric machines in which it may be employed.—*September 21st*, 1933.

Nº398,605



TRANSFORMERS AND CONVERTERS.

398,583. April 29th, 1932.—ALTERNATING-CURRENT ELECTRIC DISTRIBUTION SYSTEMS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

It is often desirable to be able to transform three-phase power with two single-phase transformers. If, for example, one of a bank of three single-phase transformers should fail, it is very advantageous to be able to continue to transform three-phase power in a satisfactory and substantially balanced manner with the remaining two transformers. Heretofore these results have been achieved to a limited extent by the use of two single-phase transformers connected in open delta or V, but the disadvantages of this scheme are well known. According to the invention, the interconnection of the two three-phase circuits is effected by two single-phase transformers, each having two identical primary and two identical secondary windings, one of the primary and one of the secondary windings of each transformer being connected individually in a phase of their respective circuits, while the remaining primary and secondary windings are connected in series in the remaining phase of their respective circuits. Let it be assumed that transformer A, Fig. 1, has failed or that it is desired to secure substantially balanced three-phase transformation by the use of transformers B and C only. Under these circumstances these two transformers are connected as shown in Fig. 2. For purposes of illustration the upper windings are shown to be equivalent star connected, while the lower windings are equivalent delta connected. It will be obvious, however, that these connections could be reversed, if desired, or they could both be equivalent star or equivalent delta connected without departing from the invention in its broad aspects.—*September 21st*, 1933.

Nº398.583

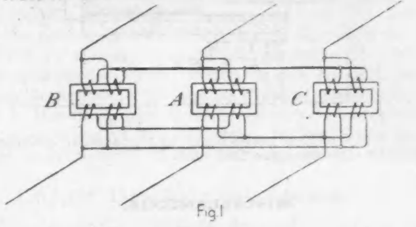


Fig 1

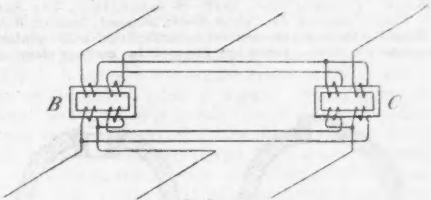


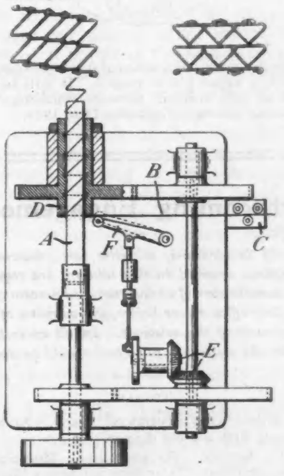
Fig 2

MACHINE TOOLS AND SHOP APPLIANCES.

398,781. May 23rd, 1933.—WIRE NETTING MACHINES, Maschinenfabrik Wafios A.G., and O. C. Schmid, 49, Karlstrasse, Reutlingen, Wurtemburg, Germany.

The essential parts of a machine for producing wire netting of the two types shown in the sketches are shown in the drawing. It comprises a flat rotatable mandrel A on which the wire B is wound after passing through a straightening device C. The mandrel rotates within a snugly fitting sleeve D, formed internally with two helical grooves, one of which is arranged diametrically opposite the other. In these grooves the wire convolutions are engaged at the edges of the mandrel and extended to attain the required shape. For this purpose the mandrel and sleeve are rotated in the same direction, the latter at half the speed of the former. One edge of the mandrel always coincides with one of the entrances to the grooves when it passes the feeding position of the wire. The latter is engaged in the groove and entrained thereby while it places itself across the adjacent flat side of the mandrel. When the opposite edge of the mandrel reaches the feeding position, there is no groove to receive the wire, and the latter will therefore slide along the intact edge of the sleeve during the next half revolution of the mandrel. During this half of the mandrel revolution, therefore, the wire will place itself across the mandrel at right angles to the edges thereof. Thereupon the process is repeated. The mandrel shaft and the sleeve are driven by appropriate gearing. By means of bevel gears E a crank pin reciprocates a plunger which rocks a lever F to press the wire into engagement with the grooves and thus ensure a reliable operation of the apparatus. The mandrel and sleeve may be exchanged to suit the desired wire dimensions and size of meshes.—*September 21st*, 1933.

Nº398,781



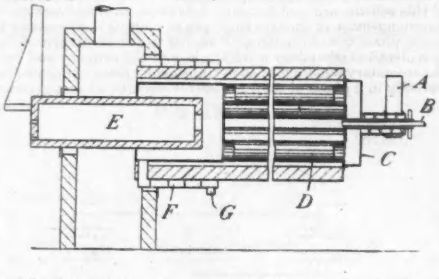
METALLURGY.

398,770. April 19th, 1932.—THE DISTILLATION OF READILY VOLATISABLE METALS, Fried. Krupp Grusonwerk Aktiengesellschaft, Magdeburg-Buckau, Germany.

It is complained in this specification that with the usual systems of distilling zinc and similar metals a proportion of the useful metal may be lost on account of its being carried away through condensation on the residue. The kiln recommended by the inventors is of the rotary type and is fed at A by means of a screw conveyor. It is also fired at this end through the supply

B. The ore passes into the annulus C, which feeds the rotating retorts D. The gaseous products, which contain the recoverable metal, go on to the condenser E, which rotates with the retorts D, while the residue passes away by the annular chamber F and outlet G.—*September 21st*, 1933.

N°398,770

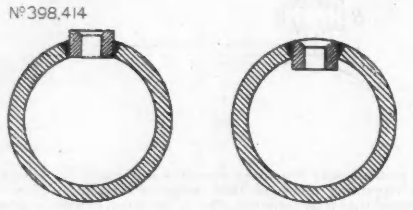


MISCELLANEOUS.

398,414. February 28th, 1933.—SUPERHEATERS, *The Superheater Company, Ltd., Bush House, Aldwych, London, W.C.2.*

Headers for superheaters are manufactured with reinforced portions where the tubes are inserted by making them of a plate bent round to form an almost complete tube, and welding, autogenously, into the gap formed between the edges of the plate a heavy bar, which is drilled for the accommodation of the tubes or any other appurtenances. The illustration needs no comment.—*September 14th*, 1933.

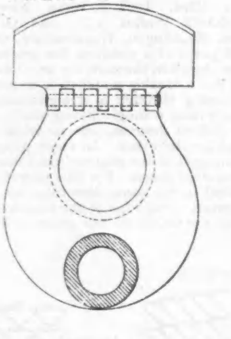
N°398,414



398,416. March 1st, 1933.—CRANK SHAFTS, M. Birkigt, Rue du Capitaine Guynemer, Bois-Colombes (Seine), France.

The balance weights of this crank shaft are connected with the crank webs by means of a series of inter-engaging projections through which a taper pin is passed. It will be appreciated that the pin is only subject, through centrifugal force, to a multiple shearing action.—*September 14th*, 1933.

N°398,416



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

FARADAY HOUSE OLD STUDENTS' ASSOC.—At Savoy Hotel, W.C.2. Twenty-fifth annual dinner.

INST. OF BRITISH FOUNDRYMEN.—Municipal College, Ormerod-road, Burnley. "Continuous Casting Plant," Mr. F. J. Cook. 7.15 p.m.

INST. OF MARINE ENGINEERS.—Grosvenor House, Park-lane, W.1. Annual conversazione. 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Thomas Hawksley Lecture, "Kinematic Design in Engineering," Professor A. F. C. Pollard. 6 p.m.

INST. OF PRODUCTION ENGINEERS: LONDON SECTION.—83, Pall Mall, S.W.1. "Modern Production Acetylene," Mr. C. Helsby. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Safety and Efficiency in Electrical Installation Work," Mr. W. F. C. Cooper. 7.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS.—In Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. Andrew Laing Lecture, "Recent Metallurgical Developments and their Significance for Shipbuilding and Marine Engineering," Prof. F. C. Lea. 7 p.m.

PHYSICAL SOC.—At Imperial College of Science and Technology, S. Kensington, S.W.7. Editing Committee meeting, 3.30 p.m. Council meeting, 4 p.m. Meeting, 5 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Train Ferries: Their History and Development," Mr. S. R. Yates. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, Sir Arthur Hill. 9 p.m.

SATURDAY, NOVEMBER 4TH.

INST. OF BRITISH FOUNDRYMEN.—At Engineers' Club, Manchester. "Continuous Casting Plant," Mr. F. J. Cook. 4 p.m.

INST. OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS.—Visit to the Hunslet Engine Company, Ltd., Jack-lane, Leeds. Meet at Corn Exchange, Leeds, 2.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "The Course and Causes of the World Depression," Mr. L. C. Robbins. 3 p.m.

MONDAY, NOVEMBER 6TH.

INST. OF PRODUCTION ENGINEERS: SHEFFIELD SECTION.—Royal Victoria Hotel, Sheffield. "Payment by Results," Mr. S. Carlton Smith. 7.30 p.m.

KEIGHLEY ASSOC. OF ENGINEERS.—Visit to works of Brook Motors, Ltd., Empress Works, Huddersfield. Between 1 p.m. and 4.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. General meeting. 5 p.m.

SOC. OF CHEMICAL INDUSTRY.—At Chemical Soc., Burlington House, W.1. Jubilee Memorial Lecture, "Some Fundamental Scientific Problems of the Food Industry," Dr. L. H. Lampitt. 8 p.m.

SOC. OF ENGINEERS.—In the Rooms of the Geological Soc., Burlington House, W.1. "Nasmyth: Father and Son," Mr. John Wilkie. 6 p.m.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOC.—The Co-operative Hall, Stafford-street, Wolverhampton. The Thomas Lowe Gray Lecture, "Eight Years' Salvage Work at Scapa Flow," Mr. E. F. Cox. 7.30 p.m.

TUESDAY, NOVEMBER 7TH.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Transmission Principles," Mr L. H. Pomeroy. 7.45 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Presentation of Medals awarded by Council. Presidential address, Sir H. P. Maybury, G.B.E. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Visit to the Post Office (London) Railway. 6.40 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND STUDENTS' SECTION.—James Watt Memorial Inst., Birmingham. "The Limiting Features of the Alternating Current System of Power Transmission," Mr. H. Rissik. 7 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Liquid Fuels from Coal for Naval Purposes," Eng.-Capt. S. H. Dunlop, R.N. 7.30 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—In the Girls' High School, Dudley. "The Interpretation of a Photomicrograph," Mr. J. W. Jones. 7 p.m.

INST. OF PRODUCTION ENGINEERS: EASTERN COUNTIES' SECTION.—In Lecture Hall, Public Library, Ipswich. "Costing and Allocation of Overheads," Mr. K. S. Jewson. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—Joint meeting with Inst. of British Foundrymen, 198, West-street, Sheffield. Discussion on First Report of the Steel Castings Committee. Introduced by Drs. H. Moore and R. N. Greaves. 7.30 p.m.

TUESDAY AND WEDNESDAY, NOVEMBER 7TH AND 8TH.

INST. OF GAS ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Fifth autumn research meeting. Morning sessions, 10 a.m.; afternoon sessions, 2.30 p.m. (See page 406.)

WEDNESDAY, NOVEMBER 8TH.

INST. OF PRODUCTION ENGINEERS: LUTON, BEDFORD, AND DISTRICT SECTION.—Castle-street Hall, Luton. "The Cost of Fine Accuracy," Messrs. B. C. Jenkins, R. Broomhead, and O. Carlton Smith. 7.30 p.m.

INST. OF WELDING ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Planning for Production by Welding," Mr. G. M. Buchanan. 7.45 p.m.

NEWCOMEN SOC.—At Inst. of Structural Engineers, 10, Upper Belgrave-street, S.W.1. Annual general meeting. "Sir Christopher Wren as a Structural Engineer," Mr. S. B. Hamilton. 5.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Excavations at Ur." Dr. C. Leonard Woolley. 8 p.m.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—Visit to Canning Town Glass Works, Stephenson-street, Canning Town, E.16. 7.30 p.m.

THURSDAY, NOVEMBER 9TH.

CHEMICAL ENGINEERING GROUP.—Joint meeting with the Oil and Colour Chemists' Assoc. at Inst. of Chemistry, 30, Russell-square, W.C.1. Discussion, "Function of Paint as a Metal Preservative." Opener, Dr. L. A. Jordan. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C.2. "Lower Voltage Sections of the British Grid System," Mr. C. W. Marshall. 6 p.m.

INST. OF ENGINEERING INSPECTION.—In Hall of Junior Inst. of Engineers, 39, Victoria-street, S.W.1. "The Prevention of Vibration and Noise," Mr. Robert B. Gray. 5.45 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. Junior Section. "Pumps for Marine Service," Mr. F. M. Jones. 7 p.m.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—At James Watt Memorial Inst., York House, Birmingham. "Rainfall as of Interest to Engineers," Mr. A. A. Barnes. 6 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE.—Hotel Metropole, Leeds. "Designing for Welding," Mr. C. Helsby. 7 p.m.

INST. OF METALS: LONDON LOCAL SECTION.—At Royal School of Mines, S. Kensington. "Gold—its Sources and Production," Mr. R. Annan. 8 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: iv., Injection: Processes in the Cylinder," Dr. S. J. Davies. 5.30 p.m.

FRIDAY, NOVEMBER 10TH.

INST. OF BRITISH FOUNDRYMEN.—At the Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. "Routine Methods of Testing Green Sands," Mr. N. D. Ridsdale. 7.45 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Discussion, "Financing Industry," introduced by Mr. Sydney Parkes. 7 p.m.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Victoria Embankment, W.C.2. "The Use of Electricity in Rural Areas," Mr. A. L. Cain. 6.15 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—In Nonferrous Section of Applied Science Department of University, St. George's-square, Sheffield. "Metal Spraying," Mr. W. E. Ballard. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Annual general meeting. 7.30 p.m.

KEIGHLEY ASSOC. OF ENGINEERS.—Queen's Hotel, Keighley. "Petroleum: From Well to Consumer," Mr. F. L. Slee. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, Mr. N. V. Sidgwick. 9 p.m.

SATURDAY, NOVEMBER 11TH.

INST. OF BRITISH FOUNDRYMEN.—Technical College, Monks-road, Lincoln. "Use of Refractory Materials in the Foundry," Dr. J. G. A. Skerl. 7 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—85–88, The Minories, E.C.3. Social and dance. 7.30 p.m.–11.15 p.m.

INST. OF MECH. ENGINEERS: GRADUATES.—Visit to Brookman's Park Wireless Station. Particulars from Hon. Sec., Graduates' Section, 28, Essex street, Strand, W.C.2.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "The Course and Causes of the World Depression," Mr. L. C. Robbins. 3 p.m.

MONDAY, NOVEMBER 13TH, TO SATURDAY, NOVEMBER 18TH.

PUBLIC WORKS CONGRESS AND EXHIBITION.—Agricultural Hall, Islington, N.1. Daily. (For programme see page 365).

MONDAY, NOVEMBER 13TH.

INST. OF METALS: SCOTTISH LOCAL SECTION.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Discussion on papers presented at the autumn meeting of the parent Institute. 7.30 p.m.

STEPHENSON LOCOMOTIVE SOC. (SCOTLAND).—In L.M.S.R. Societies' Room, Royal Technical College, Glasgow. "The Economic Life of the Locomotive," Mr. John Scott. 7.45 p.m.

TUESDAY, NOVEMBER 14TH.

CHEMICAL ENGINEERING GROUP.—At the Public Works, Roads, and Transport Exhibition, Royal Agricultural Hall, Islington, N.1. Conference, "The Mechanical Testing of Bituminous Road Materials." Sessions 11 a.m. and 3 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At King's Head Hotel, Coventry. "Transmission Principles," Mr. L. H. Pomeroy. 7.30 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "Welding for Pressure Vessels," Mr. R. Sulzer. 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—In James Watt Memorial Inst., Birmingham. "Deoxidisers and Fluxes," Mr. G. L. Bailey. 7 p.m.

INST. OF METALS: N.E. COAST LOCAL SECTION.—Joint meeting with the Newcastle-upon-Tyne Branch of Soc. of Chemical Industry, in Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. "Metal Spraying," Mr. W. E. Ballard. 7.30 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—At Y.M.C.A., Swansea. "Ageing and Age Hardening," Dr. Cecil H. Desch, F.R.S. 6.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Intergranular Corrosion of 18/8 Austenitic Steels," Mr. E. C. Rollason. 7.30 p.m.

WEDNESDAY, NOVEMBER 15TH.

INST. OF ELECTRICAL ENGINEERS: METER AND INSTRUMENT SECTION.—Pagani's Restaurant, 42, Gt. Portland-street, W.1. Annual dinner. 6.45 p.m. for 7 p.m.

MANCHESTER METALLURGICAL SOC.—At College of Technology, Manchester. "Hardness of Metals," Dr. H. O'Neill. 7 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS: GRADUATES.—Bolbec Hall, Newcastle-upon-Tyne. "Leaves from an Engineer's Log," Eng.-Comr. C. J. Hawkes, R.N. 7.15 p.m.

THURSDAY, NOVEMBER 16TH.

BRITISH WATERWORKS ASSOC.—Agricultural Hall, Islington, N.1. To receive and discuss the following papers:—"Pooling of Supplies by Interconnection of Water Undertakings and their Trunk Mains through Rural Areas," Mr. Alan E. L. Chorlton; "Water Pollution Research," Dr. A. Parker. 11 a.m. Afternoon session: "The Financial Management of Municipal Trading Departments," Mr. Sydney Larkin; "Water Supply and Fire Protection," Mr. John Smith; "Fire Prevention and Fire Extinguishing Apparatus," Major F. W. Jackson; "The Legal Aspect of Water Supply for Fire Protection Purposes," Mr. John Hall. 2.45 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS: TEES-SIDE BRANCH.—Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. "Rudder Streamlining Technique," Dr. E. V. Telfer. 7.30 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: v., Ignition and Combustion Properties of Fuels," Dr. S. J. Davies. 5.30 p.m.

FRIDAY, NOVEMBER 17TH.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOC.—At Inst. of Chemistry. Sixteenth Streatfield Memorial Lecture, "Beer," Mr. H. F. E. Hulton. 8 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Recording Sound for Motion Pictures," Mr. W. Harris. 7.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. "Economics in Tramp Ship Design," Mr. W. Leslie Runciman. 6 p.m.

OVERHEAD LINES ASSOCIATION.—At Georgian Restaurant, Harrods, Ltd. Annual conversazione.

MONDAY, NOVEMBER 20TH.

INST. OF ELECTRICAL ENGINEERS: WESTERN CENTRE.—At Cheltenham. Discussion on "Gale and Storm Damage." Opener, Mr. W. D. Tuck.

TUESDAY, NOVEMBER 21ST.

INST. OF AUTOMOBILE ENGINEERS.—At Victoria Hotel, Wolverhampton. "The Correlation of Metallurgical and Economic Problems in the Selection of Automobile Engineering Materials," Mr. L. B. Hunt. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. Discussion, "Rolling Faults in Steel," Mr. G. M. Brown. 7.30 p.m.

WEDNESDAY, NOVEMBER 22ND.

INST. OF AUTOMOBILE ENGINEERS.—At Engineers' Club, Albert-square, Manchester. "Transmission Principles," Mr. L. H. Pomeroy. 7 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Radiographic Use of Radium," Dr. V. E. Pullin. 8 p.m.

THURSDAY, NOVEMBER 23RD.

ANNUAL CHEMICAL DINNER.—Wharncliffe Rooms, Hotel Great Central, Marylebone, N.W.1. Dinner, 7.30; dancing, 9.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Applications of X-rays to Metallurgical Investigations," Mr. J. W. Rodgers. 7.30 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: vi., Designs of Combustion Chambers—Actual Performance—Trends of Development," Dr. S. J. Davies. 5.30 p.m.

TUESDAY, NOVEMBER 28TH.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Grosvenor Restaurant, Gordon-street, Glasgow, C.2. Annual dinner and ladies' evening. 6.30 p.m. for 7 p.m.

THURSDAY, NOVEMBER 30TH.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOC.—Hotel Metropole, Leeds. Short paper by students for discussion. "Tramway Reconstruction," Mr. C. R. Warman: "An Economic Aspect of Reinforced Concrete," Mr. E. A. Dyer. 7.30 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—In James Watt Memorial Inst., Birmingham. "Symposium on Defects in Cold Working," arranged by Mr. A. L. Molineaux. 7 p.m.

A Seven-Day Journal

The "Back to Coal" Movement.

In a Journal note of August 26th, 1932, we referred to the strengthening of the "Back to Coal" movement by the co-operation of a number of coal-utilisation experts and Welsh Members of Parliament. Following up its efforts to secure the substitution of coal for oil for use on British naval vessels, the "Back to Coal" movement has again petitioned the Board of Admiralty to receive a deputation to enable the members to place their case before the Board. The communication is signed by the Lord Mayor of Cardiff, as President of the movement, and by the three hon. secretaries. The letter recalls that in July, 1931, a deputation interviewed the Lords of the Admiralty, but the late Board of Admiralty then found itself unable to accede to the deputation's request by reason of existing conditions in regard to construction and equipment, which were dictated for the most part by the necessity to ensure the greatest possible advantages while maintaining international agreements. The movement has been advised that these conditions may not necessarily continue, and that, in fact, considerable changes have already taken place. For this reason there is a strong feeling throughout South Wales that events subsequent to July, 1931, have considerably strengthened the case which was laid before the previous Board. The movement therefore desires to know whether the present Board of Admiralty will receive a second deputation. If so, it is proposed that, with the consent of the Board of Admiralty, such a deputation should be supported by coal utilisation experts.

Business Forecast.

The F.B.I. Business Forecast for the fourth quarter of the year reflects the general upward movement of industry. It is that "despite the many unfavourable factors still operating in the international field, and in particular the recent setback in the U.S.A., it is possible to view the future with optimism. The world may be said to have planted its feet so firmly on the road to recovery that it will take something more drastic that such transitory events as the instability of the French franc or the American dollar to divert it from its course. Even should there be some modification of the French gold standard, or a further appreciable flight from the dollar, there is no reason why we should not be able to retain control of our domestic situation. The same is true of many other countries." The quarterly report of the Federation notes that a large part of the recovery in the third quarter of the year was attributable to home trade, but that the recovery in our foreign trade also gathered some momentum during the quarter. Domestic exports increased from a monthly average of £21·9 millions to £23·8 millions, while retained imports rose from £11·5 millions to £13·4 millions.

G.W.R. Development Schemes.

At the end of last week the Great Western Railway Company announced a two million building programme for the coming year. The locomotive programme includes the construction of ninety engines, ten of which will be of the four-cylinder 4-6-0 "Castle" class and ten of the two-cylinder 4-6-0 "Hall" class for use on the principal express passenger trains. Another thirty engines will be for local and suburban service, and there will also be twenty-five engines of the 0-6-0 tank class and fifteen auto engines. The rolling stock programme includes 200 passenger vehicles and, on the freight side, 850 12-ton vacuum fitted vans and 1080 12-ton non-vacuum fitted vans exceeding a total of a million pounds for rolling stock for express freight services. During 1934 over 400 miles of line are to be relaid, which will involve the use of 30,000 tons of rails and 600,000 sleepers, a proportion of which will be made of steel, while 185,000 tons of ballast will be required. Over a quarter of a million pounds is to be spent on the maintenance and reconditioning of stations, buildings, and fencing.

Coal Dust Explosions.

The recent paper No. 79, recording the experiments carried out by Mr. T. N. Mason and Mr. R. V. Wheeler for the Safety in Mines Research Board, published by the Stationery Office, marks a further advance in knowledge of the means of preventing coal dust explosions. Hitherto it has been usually assumed that the nature of the incombustible dust used for the treatment of mine dusts is unimportant. This view is supported by the Home Office Explosions in Mines Committee, which in 1914 stated that the fineness of incombustible dust rather than its chemical composition afforded a measure of its probable effectiveness in preventing the ignition of the coal dust with which it was mixed. The authors above named have recently made experiments with seven different kinds of incombustible dusts, and their results are given in the paper. Compared with the shale dusts in common use, limestone and gypsum were found to be more markedly effective in rendering coal dust incapable of propagating flame. The authors, however, give a warning in which they remind possible users that when assessing the value of an incombustible dust for the treatment of coal dust the ease with which it can be dispersed as a cloud, more particularly after it has been exposed to the atmosphere of the mine for some time, must always be considered. In this respect it is pointed out that gypsum is more likely to cake than is either limestone or shale dust.

Two Noteworthy Launches.

On Thursday afternoon, November 2nd, there was launched from the Pallion Shipyard of Short Brothers, Ltd., Sunderland, the "Arcwear," the first of three Arcform steamers which are being constructed to the order of Sir Joseph W. Isherwood and Co., Ltd. The ship is of the single-deck type with a length of 360ft., an extreme breadth of 57½ft., and a moulded depth of 26ft. 9in. She will have a deadweight carrying capacity of about 7000 tons on a summer loadline of 22ft. 7in. Steam propelling machinery will be installed, and the boilers will be designed to burn coal. The results of tests show that, at a speed of 9 knots, about 11½ tons of coal will be used, at 10 knots about 16 tons, and at 11 knots about 21 tons per day. The naming ceremony was performed by Lady Isherwood. The "Arcwear" is being constructed to Lloyds highest class, and is built on the Isherwood combined system of transverse side framing with longitudinal framing in the double bottoms and erections. The second important launch during the week was the "British Coast," the largest British coastal motor liner yet built, which was launched from the Leith yard of Henry Robb, Ltd., on Saturday, November 4th, for the service of Coast Lines, Ltd. The keel plate of a sister ship, to be named the "Atlantic Coast," was immediately laid. The new coastal liner has a deadweight carrying capacity of 1400 tons on a draught of 13ft. 11in., and she is 230ft. in length with a moulded breadth of 35ft. and a depth to shelter deck of 21ft. 6in. Her twin-screw Polar type oil engines are being supplied by British Auxiliaries, Ltd., of Glasgow, and have a designed output of 1250 B.H.P. total, corresponding to a speed of about 12 knots. The official trials will be made in December.

Chelsea Bridge.

At a meeting of the London County Council, held on Tuesday, November 7th, a report of the Improvements Committee, which recommends the reconstruction and widening of Chelsea Bridge to take four lines of wheeled traffic, was adopted. As recorded in a Journal note of June 26th, 1931, the original plan was for a new suspension bridge carrying six lines of wheeled traffic, which was to be built at an approximate cost of £659,250, to the designs of the Council's architect and Sir Frederick Palmer, P.P. Inst. C.E. The scheme now approved provides for the reconstruction and widening of the existing structure at a cost of about £480,000. The Committee proposes to consult the Royal Fine Art Commission on the design to be adopted. The new bridge will have a 40ft. carriageway and two 12ft. footpaths, and the Ministry of Transport will make a grant at a rate of 60 per cent. towards the approved expenditure. The sum of money above mentioned includes the cost of a temporary bridge while the reconstruction work is proceeding. The work will be carried out to the designs and under the supervision of Messrs. Rendel, Palmer and Tritton, of Westminster.

Improved Employment Figures.

Early in the week the Ministry of Labour announced that on October 23rd there were 44,000 more persons in employment than there were a month ago, and 537,000 more than a year ago. The estimated number of insured persons in employment last month was 9,925,000. As in the case of last month, for which the employment particulars up to that date were given in our Journal note of October 13th, the largest reduction was in coal-mining, over 13,000 more miners being employed. Reduction in unemployment continued also in the metal industries other than the manufacture of iron and steel. Thus the following decreases were noted :—General engineering, 6600; motor vehicles, &c., 5000; and metal goods manufacture, nearly 7000. In the iron and steel industry, on the other hand, unemployment increased by nearly 2800 persons, and there were also small increases in occupations affected by seasonal influences, including the following :—Building, 1000; public works contracting, 1000; road transport, 1450; shipping, 5000; and distributive trades, 4000. In all trades, however, there were remarkable decreases in unemployment compared with the returns for October last year.

Technical Education and the Future.

In an address given on Friday, November 3rd, in connection with the prize distribution at the Wolverhampton and Staffordshire Technical College, Professor E. W. Marchant, of the University of Liverpool, paid a tribute to the work the College was doing in the interests of the economic development of higher technical education. An interesting part of his address was devoted to the future development of such education. Professor Marchant suggested that owing to the mechanisation of industry the number of people employed in manufacturing work during the next decade would almost certainly diminish. It seemed to him very uncertain as to whether the standard of living, or, rather, he said, the standard of need for additional amenities, would have then advanced sufficiently to enable all those who were so displaced to enter the new factories designed to supply the new needs. For the present, at any rate, there was no doubt of a surplus of labour. Suggestions had been made for the raising of the school-leaving age in order to prevent so many young people leaving school from becoming unemployed. Could we not, he said, take a similar action in respect to evening class instruction ? If evening class instruction were to be replaced by instruction in the daytime, it would mean a great improvement in the training of the student.

Copper Development Association.

The Copper Development Association, which now occupies offices at Thames House, Millbank, S.W.1, has been recently formed in order to promote the use of copper and copper-containing materials. For the present it is proposed to concentrate on the development of extended uses of copper rather than on research work, since it is felt that such development has not kept pace with the very rapid progress which research has made during the past few years. Contact has been established with the Copper and Brass Research Association in America, and with the Copper Institute of Germany, with a view to the interchange of information. The Association has unrivalled opportunities for the collection and dissemination of information, and the hope is expressed that engineers will avail themselves of the facilities it offers. The honorary Presidents of the Association are Sir Auckland Geddes, Mr. A. Chester Beatty, and Sir Harry D. McGowan; and it is directed by a Council, of which Mr. D. Owen Evans is Chairman and Lieut.-Colonel Preston Vice-chairman. The conduct of detailed business is vested in a Management Committee, of which Mr. A. D. Storke is the Chairman, and on which most of the important copper interests, including trade associations, are represented. The Vice-chairman of the Management Committee is Mr. S. S. Taylor, and other members are Mr. W. R. Barclay, Mr. Thomas Bolton, Mr. J. C. Budd, Mr. G. W. Mullins, Mr. E. Pam, Mr. C. H. Schneider, and Mr. A. J. G. Smout. Mr. D. P. C. Neave is the general manager of the Association, and Mr. G. W. Preston, A.M.I.E.E., has been appointed its electrical engineer.

The Dowlais Steel Works Project.

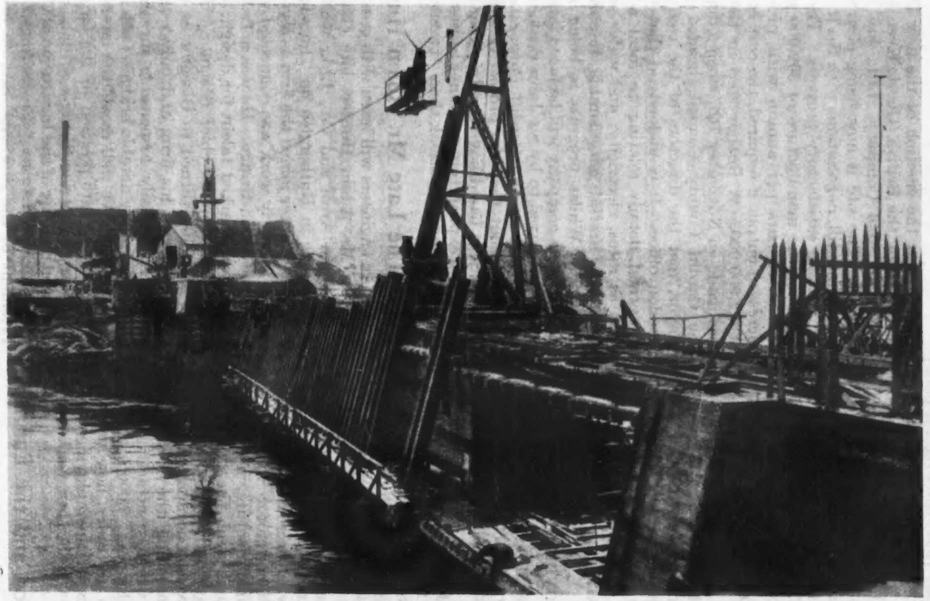
Plans for the erection of the new Dowlais works at Cardiff by the British (Guest, Keen and Baldwins) Iron and Steel Company, Ltd., are being pushed forward. The site is now being cleared, and, more important still, negotiations with the local authorities are making satisfactory progress. The scheme provides for the manufacture of 300,000 tons of billets and sheet bars per annum with provision for an increased output if required, the cost being estimated at £2,000,000. A further step in the negotiations was made on November 7th, when a deputation from the Cardiff County Council, headed by the Lord Mayor, met the directors of the company at their London office. It is understood that the discussion concerned details relating to local administration, such as rates, electricity, and water supply, which, naturally, are of considerable importance to the company. Whilst progress is being made in this direction the company will be faced later on with the problem referred to by Sir John Beale, the chairman, in his letter to the Cardiff Corporation, in which he pointed out that the protective duties on which the scheme is based have barely a year to run, whilst the capital expenditure could not be justified by a plan based on a shorter outlook than "twenty years or so."

The Late Mr. Adam Hunter.

Bridge engineers will learn with great regret of the death of Mr. Adam Hunter, late chief engineer of Sir William Arrol and Co., Ltd., which took place at his home in Rutherglen on Thursday, November 2nd. Mr. Hunter joined the firm as a young man, and some of his early work was connected with the building of the Forth Bridge. He was a Telford Medallist, and showed marked talent for design, so that he was sent to London as chief designer. About twenty years ago he returned to Glasgow as chief engineer and director of his firm, and only retired last year. He was personally responsible for the design and building of many notable bridges, both in this country and abroad. We well recall the interest he showed in the putting into position of the large span of the temporary Waterloo Bridge. Adam Hunter was an honoured member of the Institution of Civil Engineers, and contributed to its "Proceedings." He was also President of the Students' Section in Glasgow, and a President of the Glasgow University Engineering Society. His outstanding abilities as a bridge builder were widely recognised, and younger engineers owed much to his kindly advice and help, which was often sought and was never refused. His death will be widely regretted by his late colleagues, and the many engineers who from time to time consulted him in connection with bridge construction schemes.

VARGON HYDRO-ELECTRIC POWER STATION IN SWEDEN

(For description see opposite page.)



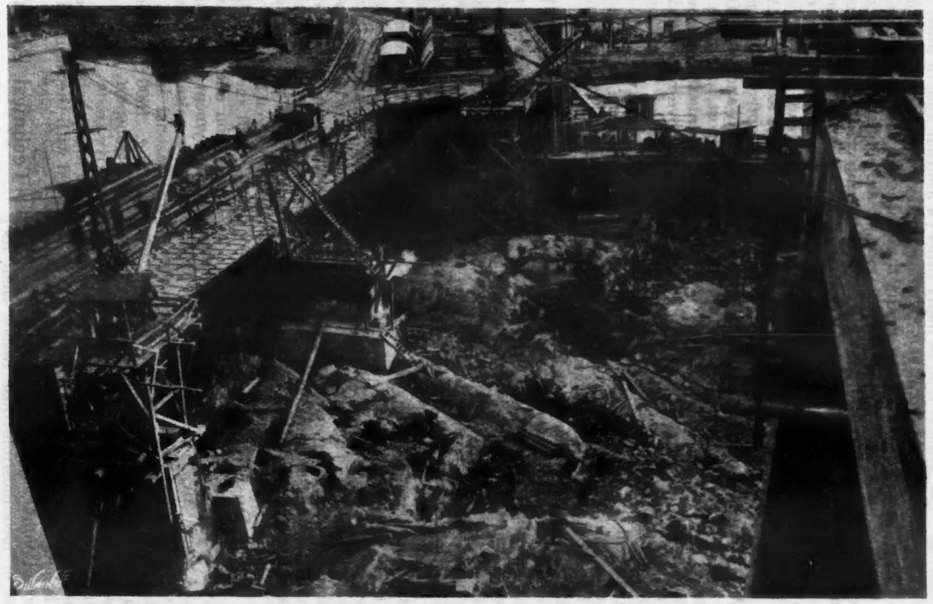
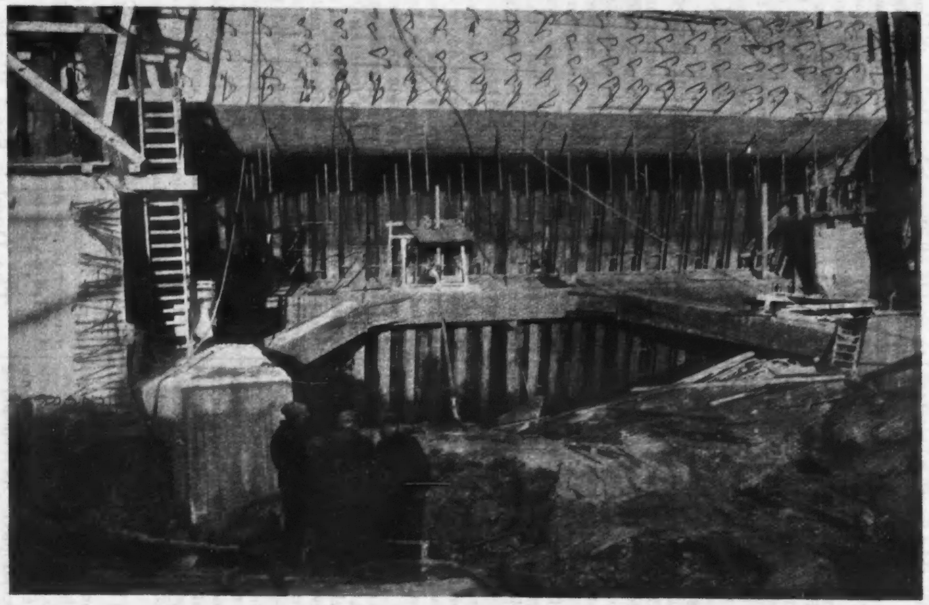


FIG. 1 (ABOVE)—VIEW OF UPSTREAM COFFERDAM DURING CONSTRUCTION—MARCH, 1932

FIG. 2 (BELOW)—VIEW OF INSIDE OF COFFERDAM AFTER PUMPING OUT—JANUARY, 1932



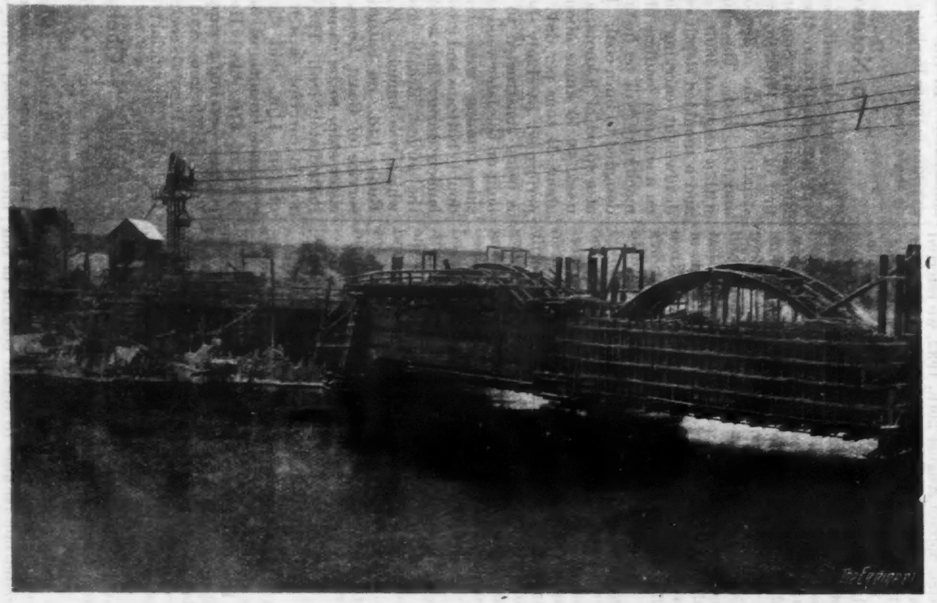


FIG. 3 (ABOVE)—SITE OF WESTERN INTAKE FROM INSIDE OF COFFERDAM—FEBRUARY, 1932

FIG. 4 (BELOW)—TIMBER SHUTTERING FOR CONSTRUCTION OF UPSTREAM PORTION OF ROOF OF INTAKES

Recent Hydro-Electric Power Plants in Sweden.

No. I.

AMONG the many hydro-electric power stations in Sweden which were visited by the members of the International Congress on Large Dams in July last are three of special interest, which we propose to describe in a short series of illustrated articles, of which this is the first. These installations are at Krangede, and at Sillre in Lower Norrland, and at Vargön near the outlet of the great lake Vänern; novel features of design and construction are exhibited in each of them. The works at Krangede are under construction and will not be in operation until 1935 or 1936; at Sillre some work was still in progress on the dam when it was visited by the members of the Congress in July, although the plant had been brought into use in April last. The first section of the Vargön works, in some respects the most interesting of the three, is now nearing completion and is expected to be in operation early in 1934. We shall also make brief reference to the older power stations, which are or will be linked with these new installations and operated in conjunction with them.

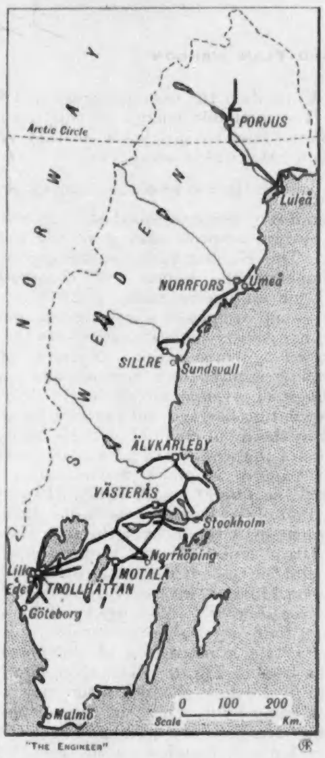

PORJUS
Arctic Circle
Luleå
NORWAY
SWEDEN
NORRFORS
Umeå
SILLRE
Sundsvall
ÄLVKARLEBY
VÄSTERÅS
Stockholm
Norrköping
MOTALA
Lilla Edet
TROLLHÄTTAN
Göteborg
Malmö
Scale 0 100 200 Km.
"The Engineer"

FIG. 5—STATE POWER STATIONS AND MAIN TRANSMISSION LINES IN SWEDEN

I.—THE HYDRO-ELECTRIC POWER PLANTS OF THE GOTA RIVER.

The Swedish Government Department responsible for the administration of State-owned electric power plants is the Royal Board of Waterfalls (Kungl. Vattenfallsstyrelsen), a body which also controls all waterfalls, developed or undeveloped, and canals belonging to the State. The Board supplies electric energy to three separate areas, viz., the Central Block, the Norrfors, and the Porjus areas—Fig. 5. The Central Block area comprises parts of Central and Southern Sweden, and the Norrfors and Porjus areas are in Upper Norrland, a large part of the latter area being within the Arctic Circle.

The bulk of the energy distributed by the State in the Central Block area is derived from hydro-electric installations on the Götaälv (Göta River), which, from the point of view of flow, is the largest river in Sweden. The first of these stations, that at Trollhättan, was brought into operation in 1910 and is the largest power plant in Sweden. The river is the outlet of Lake Vänern to the sea at Göteborg and has a total fall of about 44·3 m. in 90 kiloms. The flow of water is very even in character, thanks to the effect of the lake, whose water area is 5550 square kilometres, and is the largest in Sweden and the third largest in Europe. The new power station at Vargön, to be brought into use early in 1934, will make use of the difference in level between Lake Vänern and Trollhättan, which, when the regulation of the lake is in operation, will be, on the average, about 4·3 m. The falls at Trollhättan provide the head of 32 m. utilised at that power station and the plant at Lilla Edet, between Trollhättan and the sea, utilises the fall between the lowest level at Trollhättan and sea level, 6·5 m. Thus, on the completion of the Vargön works, the whole of the available head between Lake Vänern and the sea will be utilised.

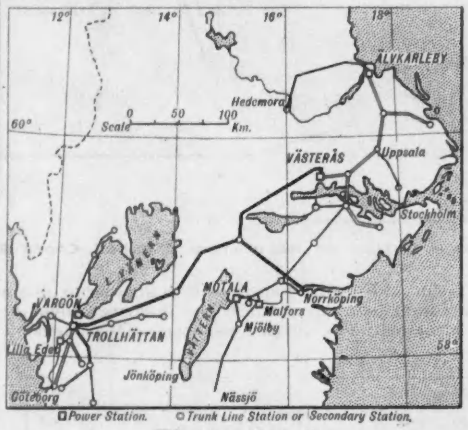

12°
14°
16°
18°
60°
58°
Scale 0 50 100 Km.
ÄLVKARLEBY
Hedemora
VÄSTERÅS
Uppsala
Stockholm
VÄNERN
VARGÖN
TROLLHÄTTAN
Lilla Edet
Göteborg
MOTALA
VÄTTERN
Norrköping
Malfors
Mjölby
Jönköping
Nässjö
Power Station.
Trunk Line Station or Secondary Station.
Trunk Line and Primary Line.
"The Engineer"

FIG. 6—POWER STATIONS AND MAIN NETWORKS OF THE CENTRAL BLOCK

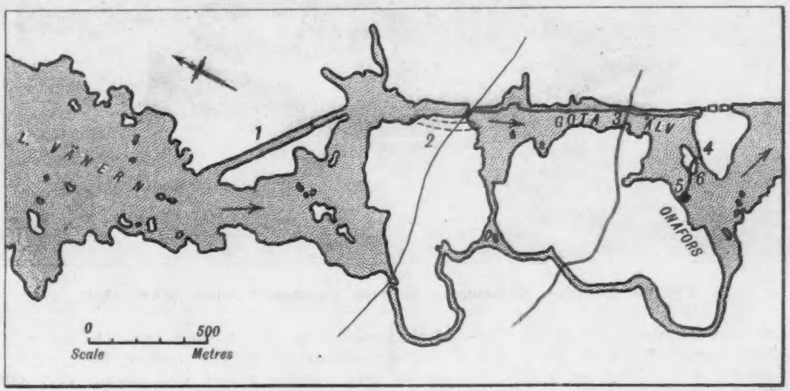

L. VÄNERN
1
2
3
GÖTA ÄLV
4
5
6
ÖNAFORS
Scale 0 500 Metres
"The Engineer"

FIG. 7—VARGON POWER PLANT—SITUATION PLAN

1.—*Canal at Sjoboda.*
2.—*Future Canal at Huvudnas Fall.*
3.—*Nyebro, where clearing has been carried out.*
4.—*Vargon Island.*
5.—*Power Station.*
6.—*Regulation Dam.*

Particulars of the Götaälv installations are given in the table above.

Plant.	In operation since.	Drainage area, kiloms.².	Kiloms. from Lake Vänern.	Flow, m.³/sec.			Utilised head. m.	Number and type of turbines.	Total installed machine capacity, kW.	Available output, kW.	Average energy available, millions kWh.	Energy produced in 1932 (net), millions kWh.	Maximum load, 1932, kW.
				Min.	Mean.	Max.							
Vargön (under construction)	(1934)	46,750	1·5	295	500	830	Min. 3·0. Max. after regulation about 5·0	2 Kaplan	About 20,000	About 20,000	115	—	
Trollhättan	1910	46,920	11	295	500	830	32·0	13 Francis	140,000	127,000	1050	812	
Lilla Edet	1926	47,470	31	300	505	835	6·5	2 vertical (fixed blades), 1 Kaplan	26,000	26,000	190	161	
Totals: Götaälv Stations ..	—	—	—	—	—	—	43·0	—	186,000	173,000	1355	973	
Totals for Central Block, including two other hydraulic stations and Västeras steam station ..							—	—	400,000	350,000	—	1288	225,900

The Trollhättan station cannot at present produce more than 127,000 kW owing to the restricted dimensions of the intake canal. When this is enlarged the full capacity of the existing plant, 140,000 kW, can be developed.

The State hydro-electric plants now in operation in the Central Block area—Fig. 6—totalling about 250,000 kW installed capacity, represent about 20 per cent. of Sweden's total developed water power. The plants are interconnected with one another and with the Västeras auxiliary steam power plant of 110,000 kW. The latter forms an energy reserve at periods of low water and a general reserve in case of emergency, and is otherwise run either as a peak load station or as a synchronous motor station to regulate the tension of the transmission system. The steam plant of the city of Göteborg (21,000 kW) also acts as a standby plant to the Central Block system.

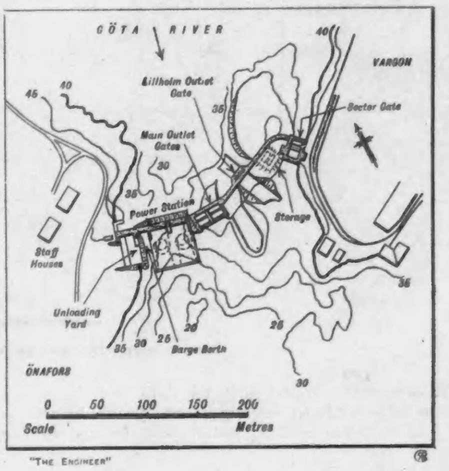

GÖTA RIVER
40
45
VARGON
Lillholm Outlet Gate
Main Outlet Gates
Sector Gate
Power Station
Storage
Staff Houses
Unloading Yard
Barge Berth
ÖNAFORS
35
30
25
20
Scale 0 50 100 150 200 Metres
"The Engineer"

FIG. 8—GENERAL PLAN OF REGULATING BARRAGE AND VARGON POWER STATION

The future network of State transmission lines, intended to connect Southern and Central Sweden with Southern Norrland, will operate under a pressure of 220,000 volts, and therefore the towers of the western trunk line Trollhättan-Västeras were designed to admit of this voltage, but at present the line is operated at 132,000 volts.

In 1929 the power demand approached the upper limit of the capacity of the Central Block plants. It was then decided to develop the water power at Vargön, near the outlet of Lake Vänern, and at Malfors on the Motala Ström. At each of the proposed stations it was possible to install turbines of over 20,000 kW capacity. The construction work at Vargön is now nearly completed, but the Malfors plant is not expected to be in use before 1935 or 1936.

The Regulation of Lake Vänern.—Regulation of the water supply from Lake Vänern became possible on the completion of the barrage at Vargön. Weekly regulation was brought into operation this year, but it is probable that yearly regulation of the lake will not be possible for several years—probably five years—as the scheme of regulation prepared by the Royal Board of Waterfalls is subject to decisions of the courts respecting the rights of landowners and others which will be affected. The possibilities of regulation of Lake Vänern are exceptionally good because of its great area. The height of regulation proposed by the Board is 1·7 m.; this storage capacity is equivalent to not less than 850 million kWh—that is, about 60 per cent. of the total quantity of energy which can be produced in a year of normal flow by making full use of the Götaälv. A change in water level of 1 cm. corresponds to about 5 million kWh.

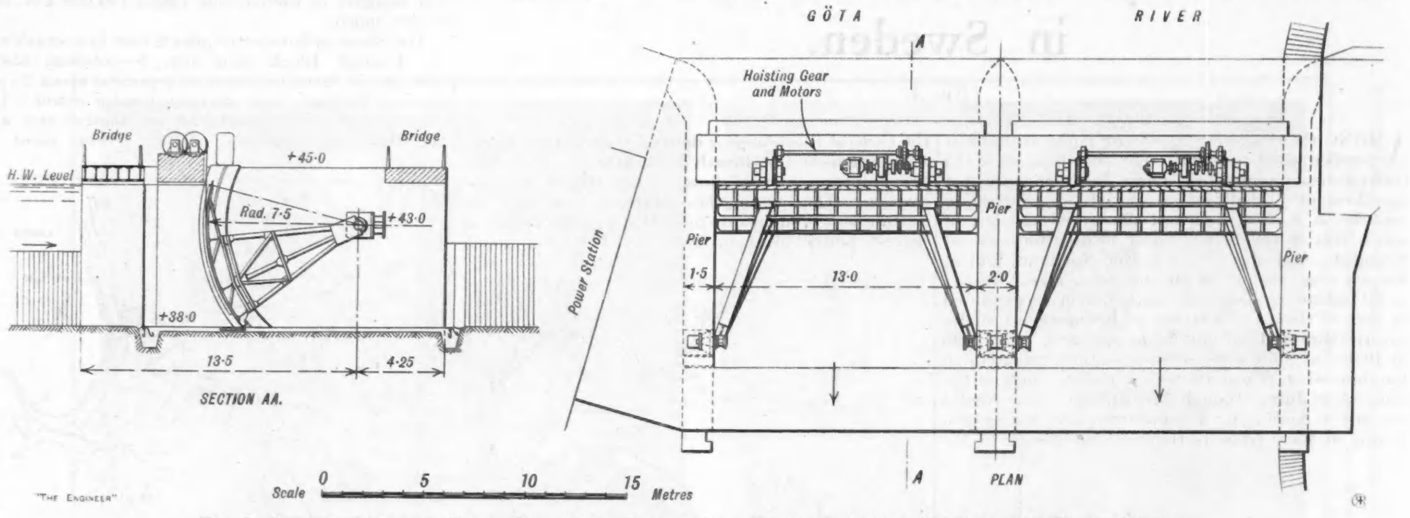


FIG. 9—SECTOR GATES IN MAIN OUTLET OF REGULATING BARRAGE—CROSS-SECTION AND PLAN—VARGON

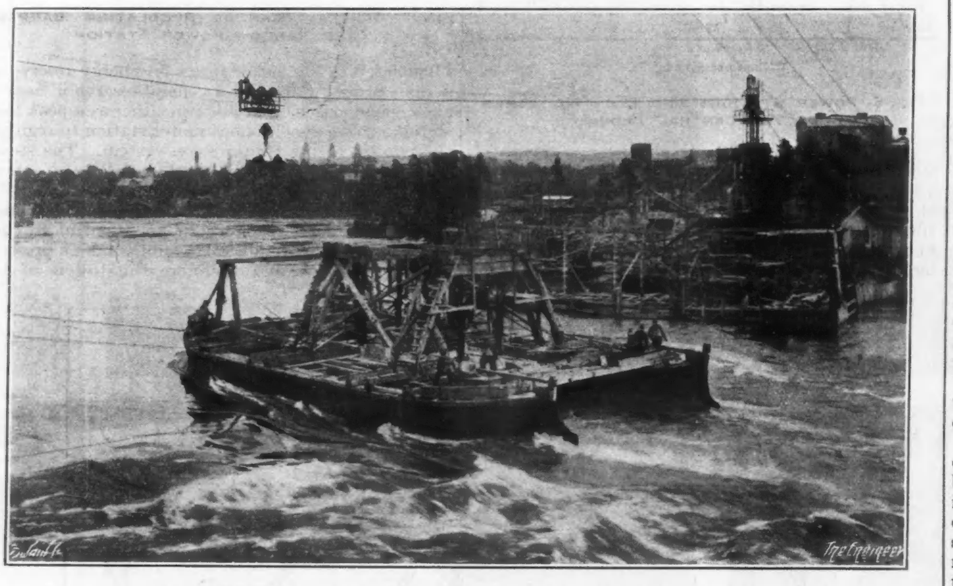


FIG. 10—SINKING A CAISSON IN THE VARGON RAPIDS—MAY, 1930

There will be a surplus of reservoir capacity available for equalisation over several years; thus advantage can be taken during low water years of savings effected during times of high water. Calculations have shown that, thanks to the great Vänern reservoir, it will be possible, by means of the Götaälv power stations, to furnish so much surplus energy to the State power systems in Central Sweden, including those to be erected in the Indalsälven in Lower Norrland, that only an insignificant supplement will be required from the steam plant during times of low water for the whole of the Board's network of power stations.

To enable the Götaälv plants to perform this duty it is proposed to enlarge them to deal with a flow up to 900 m.^{3} per second. In the future these installations will work as base load plants during the six winter months when the other State plants have at disposal only a reduced flow of water. During the six summer months their normal function will be to work as peak load plants. Tapping of Lake Vänern will only be resorted to in those years when the power plants of other systems have a low flow of water. As an example of the importance of the Vänern reservoir it may be stated that by tapping 0·25 m. of the reservoir capacity it is possible to obtain the power to produce as much electrical energy as would require about 100,000 tons of coal to produce by steam power.

The weekly regulation of Lake Vänern can be carried out without affecting the shores, provided it is possible to measure and regulate very accurately the discharge at any time. Before and during the construction of the barrage at Vargön (1929–31) an elaborate series of model experiments was carried out in the Hydraulic Structures Laboratory of the Royal Technical University at Stockholm in order to obtain accurate data upon which the discharge could be calculated under varying conditions. Measurements made from October to December, 1932, at the barrage of the actual flow were found to give results which correspond very closely with those obtained from the model experiments.*

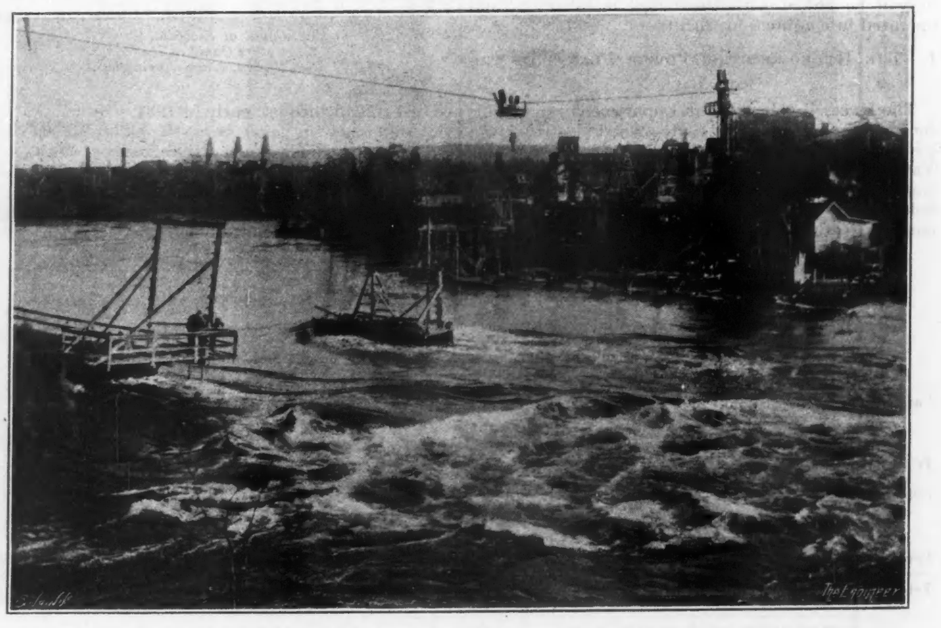


FIG. 11—THE MIDDLE CAISSON FOR THE POWER STATION FOUNDATIONS IN POSITION IN THE RAPIDS—JANUARY, 1930

After the complete regulation of Lake Vänern, the net head utilised at the Vargön power plant will have an average value of 4·3 m. and a maximum of about 5·0 m. Until then the average figure will be about 3·3 m. The available energy at this head will be about 85 million kWh. With a head of 4·3 m. 115 million kWh will be available.

THE VARGON HYDRO-ELECTRIC POWER STATION.

The plant now being installed at Vargön is remarkable in several respects and is of much technical interest. The Kaplan turbines, having runners of 8 m. diameter, the largest yet constructed, are designed for an exceptionally small head—3·0 m. to 5·0 m.—and are placed above the upstream water level; consequently the water supply to the turbines will rely on syphonic action. There is no powerhouse superstructure, the generators being housed in removable steel covers, a novelty in Swedish practice.

The regulating barrage and power station are constructed in the main channel of the Götaälv, which, at the site of the works, 1·5 kiloms. below the outlet of Lake Vänern, is about 200 m. wide, but was obstructed by several small, rocky islets—see plan, Fig. 7. Before the barrage was built—1929–31—the river formed swift rapids over the rock bed between Vargön Island and Onafors. Water traffic between the lake and the Göta River passes by way of a locked canal about 2 kiloms. west of Vargön Island.

Regulating Barrage.—The whole of the barrage, containing four outlet channels closed by gates, was built before the construction of the power station itself was begun—Fig. 8. The river flow was concentrated in the deep channel, where now the power station is being built, while the several parts of the regulating barrage were constructed in the dry within timber cofferdams founded on the rock bed of the relatively shallow side channels. Conversely, while the building of the power station has been in progress the river has discharged through the openings in the regulating barrage. Three of these openings in the barrage are provided with sector gates and the fourth is closed by a sliding gate. All these have been designed with a view to accurate measurement of the water discharge. The sector gate, 13 m. wide, at the Svarta Halan on the east side is designed for discharge

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[*] "Researches Concerning the Discharge Conditions at the Vargön Regulation Weir," by W. Fellenius and E. Lindquist. R. Tech. Univ., Stockholm; Publication No. 7, 1933.

under the gate as well as for use as an overflow weir. The two sector gates in the main outlet adjoining the power station on its east side are each 13 m. wide and are designed for discharge under the gate—Fig. 9. The Lilholm outlet has a 10 m. wide roller sluice gate.

In order to improve the flow of the river in that part which constitutes the head-race, and to minimise hydraulic losses, an artificial channel has been excavated in the rock at Sjöboda—Fig. 7. The river has also been widened and deepened along another section at Nyebro. Before the full regulation of Lake Vänern is in operation another artificial channel will be excavated in the rock at the Huvudnäs rapids—Fig. 7.

The Power Station Cofferdam.—The construction of a cofferdam, forming a rectangle of about 50 m. each way on a hard rock bottom in a river whose current flows at a rate never less than 2·5 m. per second and is sometimes as high as 3·5 m. per second, presented many difficulties. Swedish hydraulic engineers have in recent years developed a special technique in such construction. Nearly all the dams and regulating weirs or barrages that have been built in connection with hydro-electric power plants in Sweden since the early years of the present century have been in swift-flowing rivers having a rocky bed and often in the midst of turbulent rapids. Much ingenuity and skill have been shown in overcoming the difficulties of construction in such conditions, and the Vargön cofferdam is an outstanding and instructive example of this class of under-water work. It was, of course, impossible for divers to work under water except within the cofferdam or a caisson or under the lee of the upstream face of the cofferdam after that had been put in position. It was decided to make use of certain parts of the concrete structure of the power station on the upstream side as supports for the upstream face of the steel cofferdam. Portions of the concrete foundations were therefore constructed by means of three caissons. These were formed in plan so as to be suitable for incorporation in the side walls of the intakes in the permanent work. The caissons were constructed on shore and, when ready, each was suspended from staging between two barges coupled together—Fig. 10. The barges were towed upstream through the rapids and moored in the correct position for sinking the caisson. After the caisson had been sunk, Fig. 11, close junction with the rock bottom was secured by means of short sheet piles attached to the bottom edges of the caisson walls. Divers were then able to descend and carry out preparatory work on the rock bottom inside the caisson before concrete was deposited. After the three caissons had been filled with concrete placed under water, the upstream part of the concrete roof over the intakes was built upon the concrete in the caissons so as to make the latter stable against the pressure from the cofferdam wall in front of the intakes. This part of the cofferdam consists of broad flange rolled steel joists, 380 m. deep, resting on the rock bottom, as shown in Fig. 12, and spaced from 0·65 m. to 0·75 m. apart, with a grillage of flat-bottomed rails placed horizontally between the joists and the outer face of interlocked steel sheet piles. All this steel work had to be placed in position without the assistance of divers. Each of the inclined rolled steel joists was secured to the granite rock by a dowel bar of drill steel bearing against a flange of the joist and drilled into the rock from above water. These dowels are shown in the section Fig. 12 and in the view Fig. 13, where workmen are seen clipping a bar to the joist before beginning to drill by compressed air. Fig. 1 on page 448 is a view of the inclined joists of the cofferdam being placed in position in front of the intake openings. At the back of the inclined joists are two heavy horizontal built-up steel girders, 2·50 m. deep, extending across the intake openings, which were placed in position before the cofferdam face was constructed. These are shown in Fig. 12, and that in the western intake is seen in the view—Fig. 3—taken from inside the cofferdam. The steel struts at the back of the horizontal beam were put in place and the subaqueous concrete supports were cast as soon as smooth water conditions had been secured by the placing of the upstream sheet piling. The view—Fig. 2—shows the cofferdam seen from the west directly after it had been pumped out in January, 1932. On the left of the view are seen the concrete piers which had been built inside the caissons and, supported by them, the upstream portion of the roof of the intakes. A view of the timber shuttering used for the construction of this part of the roof and the steel arches supporting it is reproduced in Fig. 4.

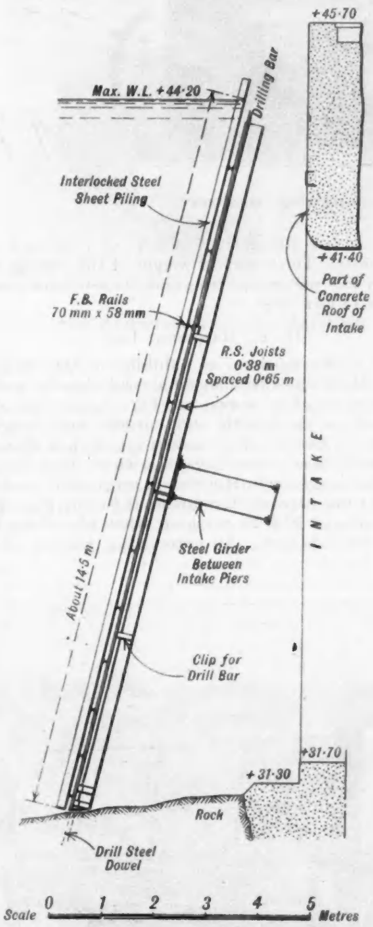

Fig. 12—Section of Upstream Cofferdam

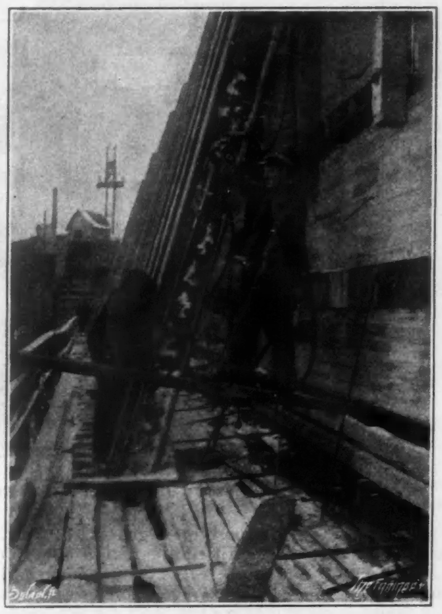

Fig. 13—Upstream Cofferdam. Drilling in Rock for Anchor Dowels—May, 1931

On the downstream side the cofferdam was built of heavy bents or trestles of rolled steel sections, spaced from 6·75 m. to 8·0 m. apart, which were lowered on to the rock bed and afterwards secured in position by concrete deposited under and around the feet of the frames. The trestles support horizontal rolled steel joists against which the interlocked steel sheet piling rests. This part of the cofferdam—Fig. 14—has a maximum height of 17 m. and was to a great extent built in still water under the lee of the previously constructed upstream cofferdam. The other cofferdams used on the works, including most of the east and west walls of the power station cofferdam, are built of timber. The advantage of the steel construction used for the upstream and downstream cofferdams is mainly that it allows the steel sheet piling to be set very close to the permanent structure of the power station where the water is comparatively shallow, as will be seen by reference to the contours shown in the plan—Fig. 8. The building of the power station cofferdam was begun in January, 1930, and completed in January, 1932.

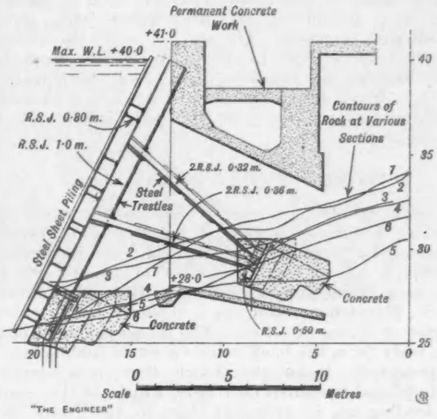

Fig. 14—Downstream Cofferdam—Typical Cross-Section

(*To be continued.*)

The Public Works, Roads, and Transport Exhibition.

No. I.

The Public Works, Roads, and Transport Exhibition, which opens in the Royal Agricultural Hall, Islington, on Monday, November 13th, for six days, until the 18th, promises to be one of the best ever held. The list of exhibitors is, we believe, longer than that for past Shows, and our preliminary investigation of the machinery and plant which they propose to exhibit suggests unusual interest. There may not be many very radical changes or novelties, but there is evidence of distinct improvement in designs and types. We start below our descriptions of some of the more prominent exhibits.

Karrier Motors, Ltd.

There will be three vehicles on the stand of Karrier Motors, Ltd., of Huddersfield, two refuse collectors, and the street sweeper illustrated by Fig. 1. The refuse collectors are both driven by 10/30 H.P. petrol engines, and have bodies equipped with sliding steel covers, of 5 cubic yards and 6 yards capacity respectively.

The sweeper, which we illustrate, is driven by a 26 horse-power, four-cylinder petrol engine, and has a body capacity of 90 cubic feet, while the water tank at the back will hold 150 gallons. It will sweep a width of 7ft., and when working travels at from 3 to 6 miles per hour, but can run at 12 miles per hour in getting to its work.

The road brush, which is 2ft. in diameter, is of a special curved type—curved, that is, in plan, but straight so far as road contact is concerned—which not only prevents the "trail" which is formed when an angular-set straight brush is employed, but also improves the sweeping generally. The brush shaft consists of seven hexagon steel tubes mounted on a non-revolving steel shaft, bent to give the required curvature. Each tube, mounted on roller bearings, is geared to its fellow so that transmission may be maintained throughout the entire length, and the whole assembly forms a compact unit which allows the changing of brushes to be carried out in a similar manner as with a straight broom, each brush centre having a hexagon core. The brush centres are fitted with "cup and ball" ends, by means of which a varying alignment is obtained without leaving a gap between the individual brush sections. The brush, which is put into action by means of a foot-operated dog clutch, is driven by totally enclosed bevel gearing, power being transmitted from the front of the gear-box by means of a worm and wheel. A hand lever situated alongside the driver enables

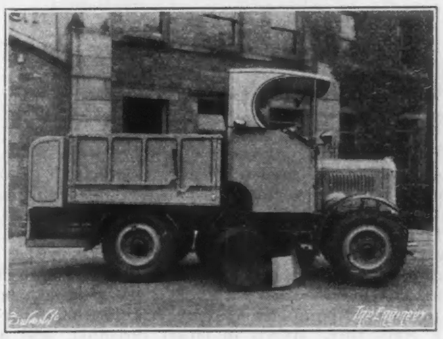

Fig. 1—Street Sweeper—Karrier

the brush to be raised or lowered at will, whilst its pressure against the road is regulated as required by means of small hand wheels. A spring-loaded balance gear gives an independent balance to each end of the brush, and so ensures freedom of movement when operating upon roads of various camber.

At the end of the road brush, on the off-side, is a quick-lifting pan arrangement, hinged to a casing and operated by cam gear. The casing contains three rotors placed one over the other, and each embodies three vanes of rubber. The intermediate rotor revolves in the opposite direction to the other two, refuse being carried from each rotor in turn to the body of the machine. On being caught by the bottom rotor, refuse is carried from this to the middle and then to the top rotor, which finally throws it into the body. Centrifugal force causes the refuse to shoot with considerable force to the extreme rear, thus preventing the discharge opening from becoming clogged. It also greatly facilitates the distribution of the load. When the body is fully loaded, the brush is raised and the machine is then driven off to the dump. After withdrawing the draw-bolts of the door, the body is side-tipped by the driver.

Walker Brothers (Wigan), Ltd.

There will be only one vehicle on the stand of Walker Brothers (Wigan), Ltd., Pagefield Works, Wigan, the household refuse collector illustrated by Fig. 2. It is one of a fleet of twenty which are now being supplied to the Borough Council of St. Marylebone, and has a capacity for 15 cubic yards, or 3 tons of refuse. The refuse is loaded into the body from the back, where a set of folding steps is provided. Inside the vehicle there is a barrier, or bulkhead, mounted on rollers, which, at the start of loading up, is arranged close to the front end of the body and is gradually drawn back as the body is filled with refuse in front of the bulkhead. This gives the men a clear floor to work on while they pile up the refuse to the maximum height. The carrying capacity is thus used to the utmost, while the dustbins are emptied under cover and their contents are not spilled about the road. An effective system of ventilation is provided by the clerestory roof. The chassis is designed to carry a total load of 5 tons, and is driven by an engine of 20–46 horse-power. The clutch is of the single dry-plate type, and the gear-box gives four speeds forward and a reverse. The engine, gear-box, and change-speed gear are all built up as one unit, and the back axle is of the Kirkstall worm-driven type. There are four-wheel brakes of the Lockheed hydraulic type, which are both hand and foot-operated, and the Woodhead springs have leaves each grooved for separate lubrication. The tires are 27in. by 6in.

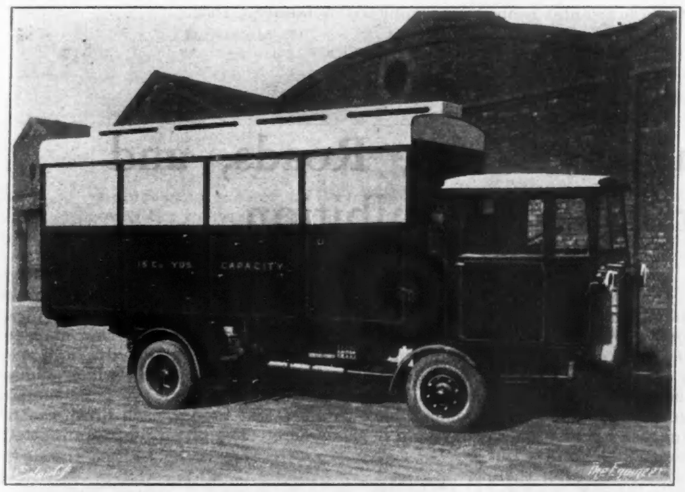

Fig. 2—Three Ton Refuse Collector—Walker

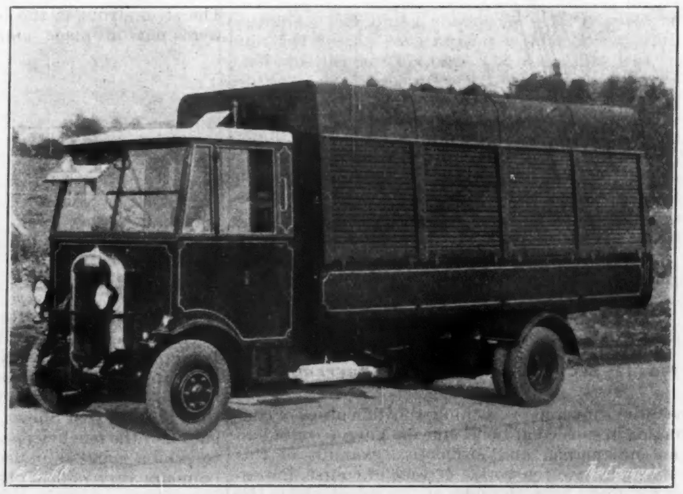

Fig. 4—12 Cubic Yard Refuse Collector—Thornycroft

Ruston and Hornsby, Ltd.

A variety of contractors' plant, ranging from a crude oil locomotive to small petrol engines, will be displayed by Ruston and Hornsby, Ltd., of Lincoln.

The locomotive, which we illustrate in Fig. 3, has a two-cylinder Lister fuel oil engine of 16–20 H.P., and will be demonstrated working on a short length of track, so that the ease with which the gears can be changed may be appreciated by visitors. The gear-box gives three speeds in either direction, and is operated by one lever in conjunction with a clutch. The final drive is taken to the two axles by means of chains, and radius rods are provided to maintain the tension in the chains regardless of the rise and fall of the axles in the horn plates.

There will also be a roller for grass work—aerodromes, sports fields, &c.—of 2½ tons normal weight, driven by a crude oil engine, and giving a rolling width of either 4ft. 1in. or 6ft., according to the placing of the rear rolls on their axles. This machine has four travelling speeds in either direction and has a double clutch, which gives immediate reversal without it being necessary to disengage any of the gears.

The pumping equipment shown will include a 4in. diaphragm pump driven by a Ruston petrol-paraffin engine through a roller chain and spur gearing, a portable 4½ H.P. oil engine centrifugal set, and some hand pumps.

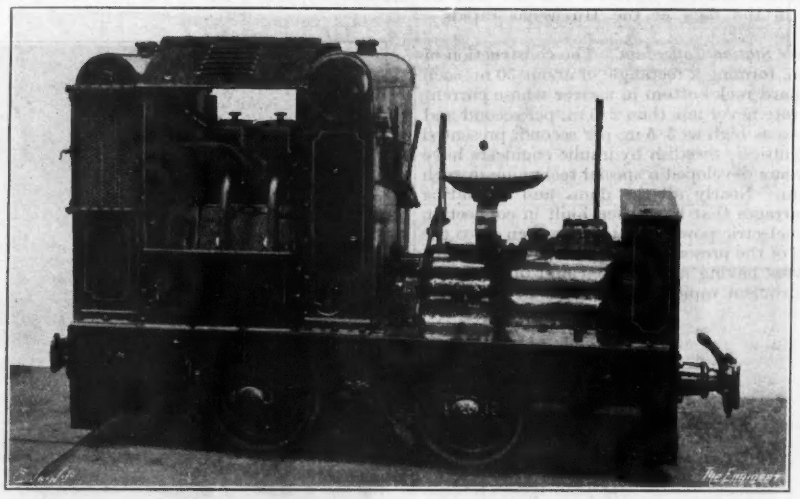

Fig. 3—16/20 H.P. Oil Engine Locomotive—Ruston

Plain straightforward oil engines will be exemplified in a 3 B.H.P. set, which is made in sizes ranging from 1½ up to 6¼ H.P.; a transportable engine of 64 B.H.P., mounted on skids so that it can be moved about on rough ground; and a 17 B.H.P. stationary horizontal engine, running at 350 revolutions per minute. This engine is capable of running on very low grades of fuel oil and its internal arrangements are to be demonstrated by a sectionalised scale model. There will also be an example of the makers' form of vertical tubular boiler for working pressures up to 120 lb. per square inch, with a looking glass arranged in the fire-box, so that the disposition of the heating surface can be easily seen.

J. I. Thornycroft and Co., Ltd.

The trend towards the more hygienic collection of household refuse will be well exemplified on the stand of J. I. Thornycroft and Co., Ltd., Smith-square, Westminster, where the main exhibit is to be the 12 cubic yard refuse collection vehicle, illustrated by Fig. 4.

This machine is composed of a standard Thornycroft 2-ton chassis fitted with Eagle bodywork, and a movable floor by the Transport Engineering Company. The floor is interesting in that it is more or less in the form of a conveyor to which there is attached a bulkhead. The idea is that the refuse should be tipped into the body with the bulkhead at the front end and the floor then drawn back, so as to squeeze the refuse against the tailboard. Such a process may be repeated several times, and then, finally, at the dump the tailboard is let down and the movable floor and bulkhead carry the load out at the back, without it being necessary to tip the body. The floor is built up of hinged steel slats and is operated by power taken from the gear-box, so that the refuse is subjected to a good squeeze by the bulkhead and the capacity of the body thus used to the utmost. The floor slats are attached to roller chains, which are driven by chain sprockets on a countershaft. The body, which is made of steel throughout, is 15ft. long by 6ft. 6in. wide, with a roof 5ft. above the floor level. The tailboard is hinged at the top and has a ratchet device which retains it in the open position during the discharge of the contents.

The chassis, as we have said, is a standard 2-ton Thornycroft, and has a wheel base of 13ft. 4¼in., while the track is 5ft. 4⅞in. The engine, of 38 H.P., has four cylinders, 3¾in. in diameter by 5in. stroke, and works in conjunction with a four-speed gear-box. The standard ratio from engine to back wheels is 6·25 to 1, but alternatives of 5·75 or 7·75 to 1 may be adopted. The standard weight of the chassis with 27in. by 6in. pneumatic tires and the usual accessories is 1 ton 18 cwt. 2 qr.

H. R. Marsden, Ltd.

One of the most novel exhibits on the stand of H. R. Marsden, Ltd., Meadow-road, Leeds, will be the stone-breaker shown in Fig. 5. It has been designed to deal with the hardest and toughest materials. One of these machines, with a 24in. by 5in. mouth, was recently tested with an exceptionally hard and tough rock, Hornfelsed greenstone, and was proved to be capable of reducing it to ¾in. and under at the rate of 10 tons per hour when absorbing 13·5 brake horse-power. An interesting feature of the frame of this machine is the method of ribbing which is arranged and proportioned to offer adequate resistance to all bending and shearing stresses, and to the sudden shocks this type of machinery is subjected to. The trouble sometimes caused by small fragments of stone lodging between the jawstock and frame is also provided against. The fixed jaws are positively locked, and a false back behind the fixed jaw prevents any possibility of ridges being formed on the frame by the jaw at this point. The excentric shaft is a solid forging, turned and ground, and revolves in four self-aligning heavy-type roller bearings. An elaborate system of labyrinth seals affords protection from dust. A power saving of approximately 60 per cent. in starting and 10 per cent. when under load is said to be effected by these anti-friction bearings as compared with bearings of white metal. Stability and the absence of vibration are noticeable qualities of the machine, and the low, "squat" appearance, palpable in our illustration, gives an impression of latent strength.

Although the Mitchell electric vibrating screen, which is to be shown on this stand, has a generally smaller screening area than several other types, the capacity is said to be greater than any other vibrating screen of equal size. It is peculiar inasmuch as it does not depend upon belts, cams, levers, chains, or any unrelated moving parts for operation. The vibrator consists of a motor enclosed in a dust and water-tight housing. A ball is located in a special cage at each end of the rotor shaft, the balls being placed at an angle of 180 deg. in relation to each other. The rotor shaft revolves at 3600 r.p.m., and the unbalanced load of the balls against hardened steel races in the housing, combined with the gyroscopic action of the rotor, imparts an extraordinary rotary action by which the material is almost fed back on itself.

A clamp around each end of the vibrator housing holds the side plates which carry the screen cloth. Live rubber absorbers are used to damp out vibration from the frame carrying the vibrator, and such is their efficiency that a pencil may be placed upright on the supporting framework and remain steady. The vibrator is designed for 220, 440, or 550 volts, two or three phase, 50 or 60 cycles A.C., and the power absorbed is slightly under 0·75 B.H.P.

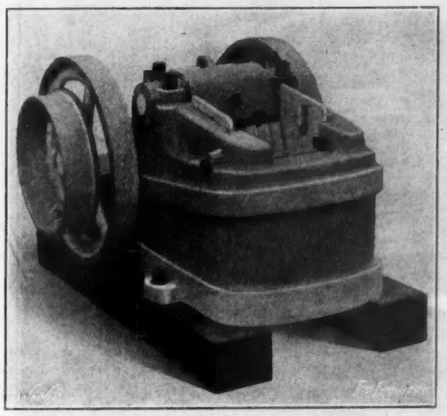
FIG. 5—STONE-BREAKER—MARSDEN

An example of each of two types of stone-breakers is also to be shown. The "X" type is operated by a single toggle and an underslung lever, the coupling to the crank shaft being made by a built-up connecting-rod. The arrangement permits of an exceptionally low centre of gravity with resultant steadiness of motion. The lever is pivoted on a machined cast steel gudgeon, its action being similar to a roller bearing. The "H" type is a modernised version of the original "Blake" stone-breaker, first produced in Europe by this firm over seventy years ago. It has the usual straightforward double-toggle mechanism actuated by an excentric shaft through a pitman, and the number of working parts is kept at a minimum.

JOHN ALLEN AND SONS (OXFORD), LTD.

There will be two stands under the name of John Allen and Sons (Oxford), Ltd., a firm with works at Cowley, near Oxford. On one in the main hall of the Exhibition there will be shown the new trench-excavating machine illustrated by Figs. 6 and 7, and some other light road-making machinery there, whilst a grader and a scraper will be exhibited in the gallery.

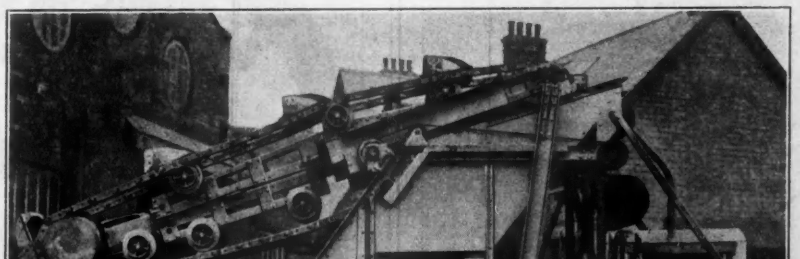
FIG. 6—TRENCH EXCAVATOR—ALLEN

The excavator, it will be seen, is mounted on chain tracks, and is capable of digging trenches from $15\frac{1}{2}$in. up to 42in. wide, and to a depth of 14ft. On the main frame there is mounted a boom carrying the excavating chain. This boom is telescopic and can be extended in steps of $12\frac{1}{2}$in. It can also be moved transversely across the main frame so that the trench is dug in the centre or on either side. The boom is raised and lowered by cables, which are operated by worm gearing that locks it in the working position and holds the buckets up to their work. The buckets, which are cast in alloy steel, are attached to two flat-link chains, and pass a cleaning device on their upward travel, so that all the soil they bring up is discharged and falls on to a transverse belt conveyor, which dumps to either side. This conveyor can be quickly shifted to clear any obstruction as the machine progresses. The machine is driven by a four-cylinder petrol engine of 36 horse-power, and has a travelling speed of 1·66 miles per hour. The digging speeds range from 11in. to 139in. per minute. The changes in speed are effected by means of a gear-box controlled by one bank of levers, which are all under the hand of the driver, so that he can adapt the running of the machine to the immediate conditions of the soil being trenched. These gears are all totally enclosed and run in an oil bath.

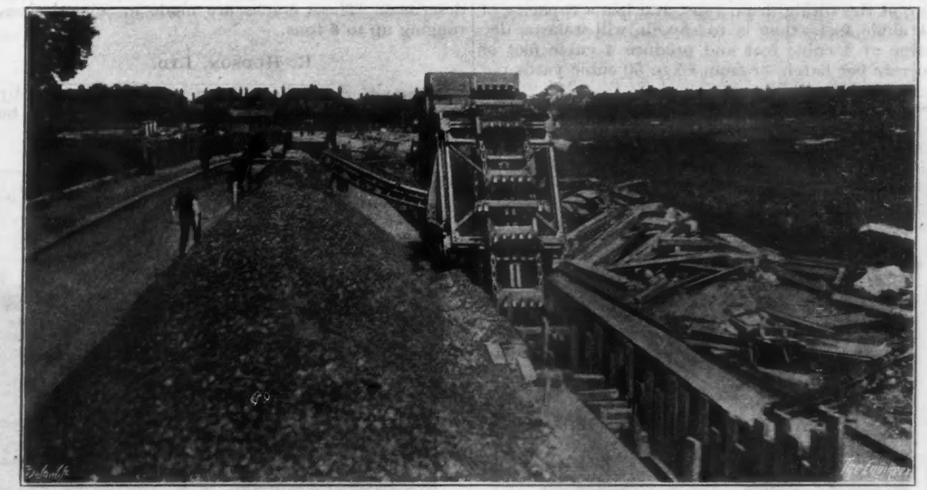
FIG. 7—TRENCH EXCAVATOR AT WORK—ALLEN

There is to be at the Exhibition a smaller machine of the same type, which will make trenches from 6in. to 12in. wide and 4ft. deep, a light roller driven by a new type of water-cooled engine, and a motor scythe.

WALLIS AND STEVENS, LTD.

Several road rollers will be exhibited on the stand of Wallis and Stevens, Ltd., Basingstoke, and will include that shown in the engraving, Fig. 8, which is driven by a compression ignition oil engine. Other exhibits comprise an 8-ton steam roller with the automatic cambering rear axle which we have described in the past; two lighter rollers, driven by oil engines; a road scarifier; a cold emulsion sprayer; and a chipping distributor.

The roller shown in Fig. 8 is equipped with a three-cylinder compression ignition engine, giving 28 B.H.P. when running at 1050 revolutions per minute. It has cylinders $4\frac{1}{8}$in. bore by 6in. stroke, and has a cylinder head and exhaust valve lifter which enable it to be started easily from cold without ignition or preheating devices. The atomisers or fuel jets are of the self-cleaning type, and the fuel pump has a separate plunger for each atomiser. The transmission from the engine is taken through a clutch to a four-speed gear-box, and thence through two reversing clutches and a reducing gear to a differential shaft. From this shaft the final drive is by spur gears direct on to both hind rolls. The differential gear can be locked from the driving position, while the roller is in motion. The road speeds, with the engine running normally, are 4, $2\frac{1}{4}$, $1\frac{1}{3}$, and $\frac{7}{8}$ m.p.h. respectively in both directions. The engine and gear-box are built as one unit, and can be readily taken out of the main frame, for which purpose large doors are provided in the side, as shown in Fig. 9. The rear axle is of the automatic cambering type, and the front roll has an underslung carriage, so that it can easily adapt itself to the contour of the road surface. The rolling width is 6ft. 4in., the hind rolls are 4ft. 6in. in diameter by 2ft. 1in. wide, and the front roll 3ft. 9in. by 3ft. The wheel base is 10ft., and the turning circle of 15ft. outside radius.

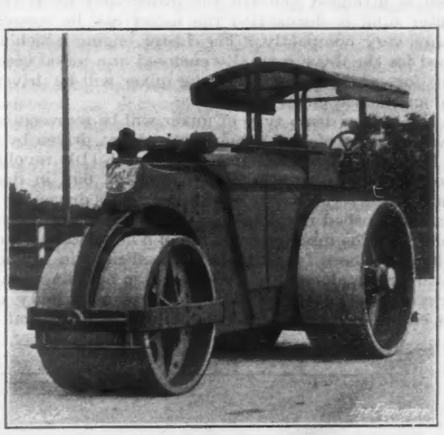
FIG. 8—$10\frac{3}{4}$-TON OIL ENGINE-DRIVEN ROLLER—WALLIS

One of the lighter rollers to be exhibited on this stand weighs $2\frac{1}{2}$ tons, and is equipped with $14\frac{1}{2}$ B.H.P. four-cylinder, side-valve, petrol engine, running at 1150 revolutions per minute. The transmission is through a four-speed gear-box, giving road speeds from 1 up to 4 m.p.h., and can be arranged to include a differential gear. The final transmission is through spur gearing. The rolling width can be varied from 3ft. $6\frac{1}{2}$in. to 4ft. $2\frac{1}{2}$in., by reversing the hind rolls on the axle.

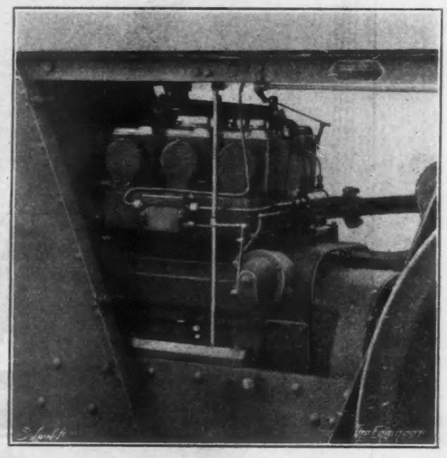
FIG. 9—ENGINE OF $10\frac{3}{4}$-TON ROLLER—WALLIS

RANSOMES AND RAPIER, LTD.

There will be an extensive display of contractors' machinery on the stand of Ransomes and Rapier, Ltd., Ipswich, including four concrete mixers, one of which we illustrate in Fig. 10, a builder's hoist, a mobile crane (see Fig. 11), and a 20 horse-power oil engine locomotive. There will also be available for inspection a 3-ton Ransomes-Rapier-Thornycroft lorry crane, capable of lifting 3 tons at a radius of 9ft. 6in., or 1¼ ton at 18ft., and able to travel at speeds up to 20 miles per hour, and a 6-ton lorry crane of much the same type.

The concrete mixer which we illustrate is, it will be seen, of the tilting drum type, and has a capacity of 6/4 cubic feet—that is to say, it will take a dry charge of 6 cubic feet and produce 4 cubic feet of concrete per batch, or from 45 to 50 cubic yards per eight hours' shift. It weighs just over a ton. All the gear is arranged beneath the drum, and when the water tank is dismantled the mixer can be stowed away very compactly. The Lister engine which is used for the drive is totally enclosed in a metal case, but for exhibition purposes the mixer will be driven by an electric motor.

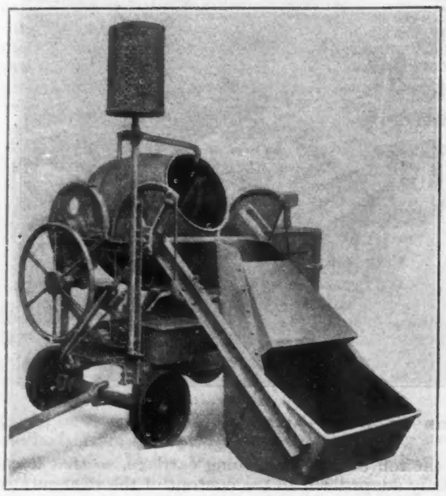

FIG. 10—TILTING DRUM CONCRETE MIXER —RANSOMES

The rotary drum type of mixer will be represented by a machine of 10/7 cubic feet capacity, driven by a 9 H.P. Lister petrol engine, running at 1100 revolutions per minute. It has a drum 4ft. 6in. in diameter, which runs on two raceways and is driven by a central toothed ring at a speed of 16 revolutions per minute. The mixing blades are of a new lattice type, which has been found to be very efficient in mixing both large and small aggregate, and in handling semi-dry or wet mixtures. The skip has a capacity of 14 cubic feet, and is lifted by means of ropes and a Spanish windlass type of hoist operated by the engine. Water is supplied to the mix by an automatic tank of a type which we have described in the past. The machine weighs 46 cwt., and has overall dimensions of 8ft. 11in. long by about 8ft. 4in. high, and a width, when travelling with the skip up, of 7ft. 6½in.

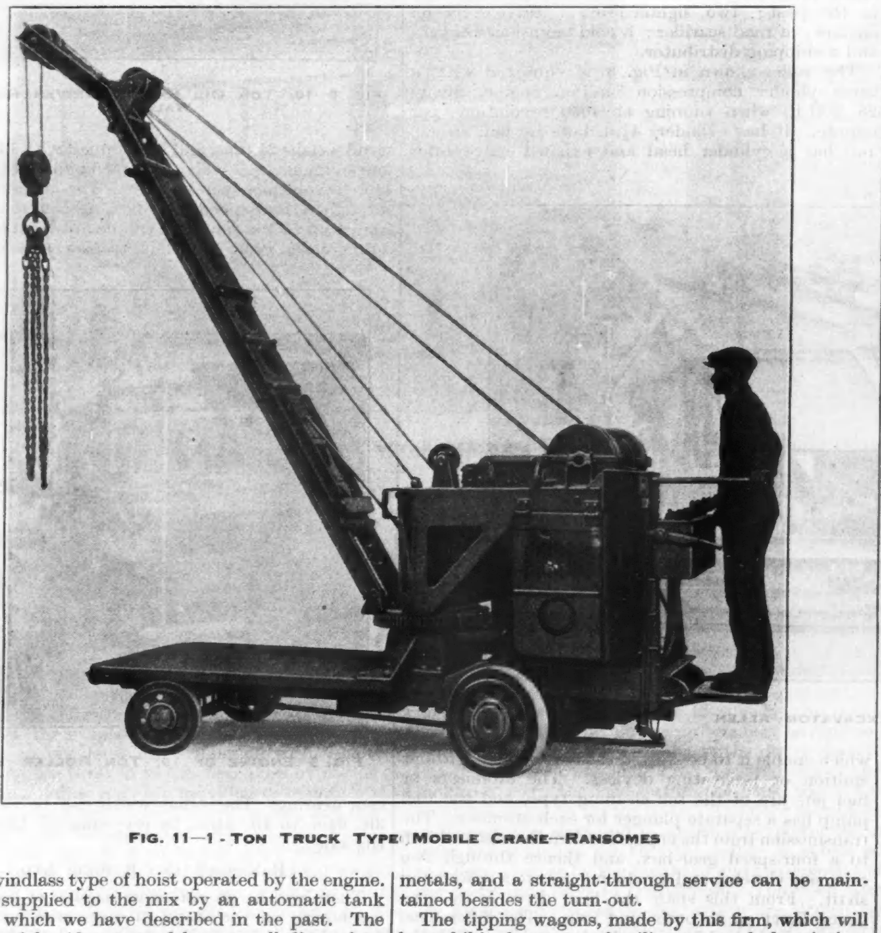

FIG. 11—1-TON TRUCK TYPE MOBILE CRANE—RANSOMES

The builder's hoist is a light steel framework, which can be either a stationary unit or mounted on wheels, up which a skip is hoisted by a 5 H.P. Lister engine. It is capable of lifting 10 cwt., at a speed of 85ft. per minute. The mobile crane, which we illustrate in Fig. 11, is of 1 ton capacity, and is operated on the petrol-electric principle, which we have already described. These cranes are made in several sizes, ranging up to 6 tons.

R. HUDSON, LTD.

Although the light railway equipment made by R. Hudson, Ltd., 28A, Bond-street, Leeds, must be familiar to most civil engineers, we think that the portable switch seen in the foreground of Fig. 12 is worthy of attention. It is, as will be gathered from the illustration, built up of a few pressings made of mild steel plate, and, literally, requires no more installation than to be put down on the metals where a turn-out is required. By turning it end for end, it can be used for a turn either to the right or the left, and the maximum lift it imposes on the rolling stock as it passes over is only 1in. It is obvious that there is no necessity to cut the railway metals, and a straight-through service can be maintained besides the turn-out.

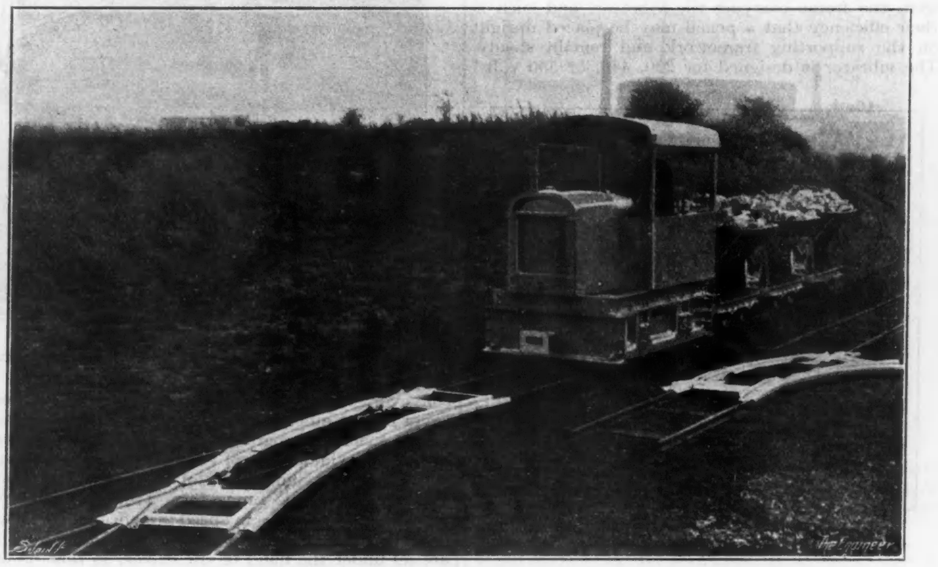

FIG. 12—LIGHT RAILWAY SWITCH AND LOCOMOTIVE—HUDSON

The tipping wagons, made by this firm, which will be exhibited are too familiar to need description, as, also, is the oil engine locomotive. In conjunction with R. H. Neal, Ltd., this firm is showing a ⅓ cubic yard concrete pouring skip.

THE GENERAL ELECTRIC COMPANY, LTD.

Among the novelties to be exhibited by the General Electric Company, Ltd., of Magnet House, Kingsway, Westminster, there will be the so-called "bollard" for traffic direction purposes, which is illustrated by the sketch, Fig. 13. It is essentially a post, with a cast iron foundation, a stalk of wrought steel tube, and a cast iron cap. One side of the tubular stalk—that facing the traffic—is cut away, and in the space so provided there is arranged a series of white enamelled reflectors, which are illuminated by a lamp just under the cap. This lamp also shows a light behind a coloured window at the top, which may be red or amber according to the exigencies of the local affairs. The exhibit will also include a typical standard lamp for street lighting, and some examples of Osira flood-lighting. This system

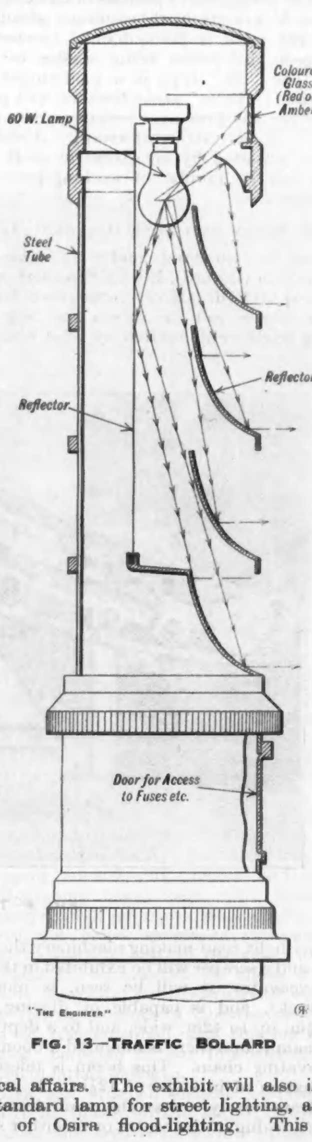

FIG. 13—TRAFFIC BOLLARD

of lighting is notable on account of the fact that it gives a very good illumination in the direction in which traffic is proceeding, while oncoming vehicles are not incommoded by glare.

R. A. Lister and Co., Ltd.

The firm of R. A. Lister and Co., Ltd., Dursley, Gloucester, will, we believe, have the distinction of staging the smallest powered compression-ignition oil engine yet made on a commercial scale. It is illustrated by Fig. 15, is of only 3 horse-power, and is, naturally, of the single-cylinder type. It runs at a speed of 600 revolutions per minute, and is said to have a fuel consumption, on full load, of less than 1½ pints of oil per hour. Among the other engines to be exhibited there will be the two-cylinder 14 H.P. set that was described and illustrated in The Engineer of October 27th, of which the outstanding feature is the ability to change the compression ratio at starting to get a good firing temperature, and then reduce it for normal running. A third engine of much the same type has three cylinders and develops 27 horse-power when running at 1000 revolutions per minute, or 31 horse-power at 1200 r.p.m.

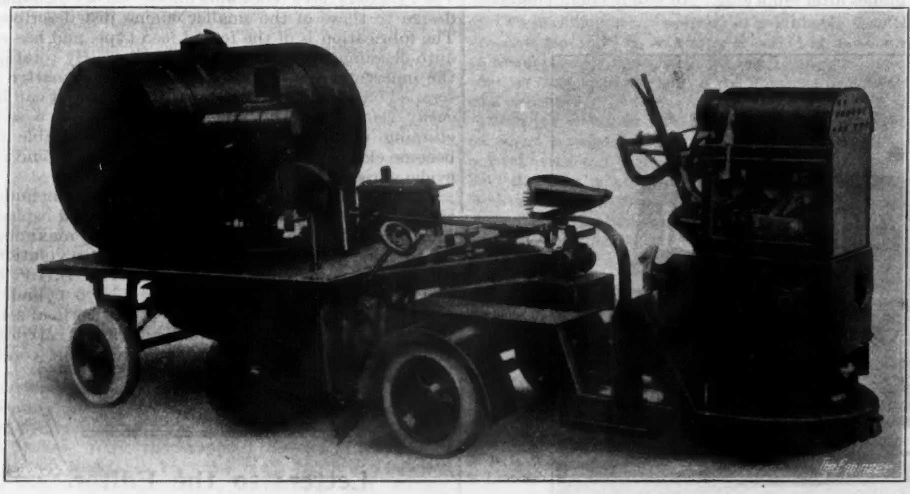
Fig. 14—Auto-Truck Cleansing Equipment—Lister

There will be also on this stand several petrol engines ranging upwards from 4 horse-power to 12 horse-power. The latter engine is arranged in a sheet metal casing, and is of that type which will be found in several parts of the Exhibition for driving contractors' machinery.

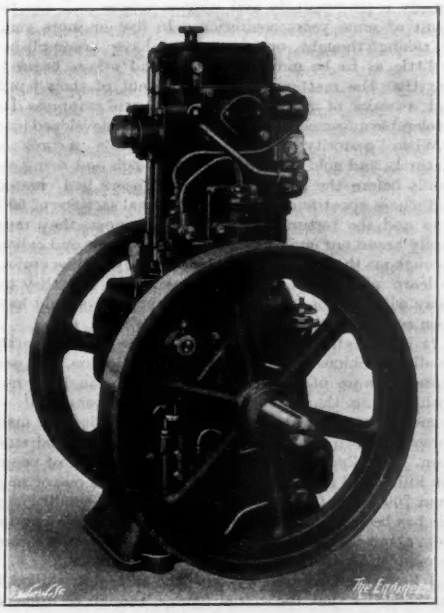
Fig. 15—3 H.P. C.I. Oil Engine—Lister

There will also be shown an adaptation of the Lister truck for working a street cleansing equipment, which is illustrated by Fig. 14. In this case, it will be seen, the truck is used to haul a trailer that comprises a road sweeper and sprinkler. The broom of the sweeper is driven by a separate 1½ horse-power engine, which also drives a pump to feed the sprinkler. The tank has a capacity of 145 gallons, and the width of the ground swept is 5ft. The equipment is capable of working up a gradient of 1 in 15. The truck is also applicable to the hauling of a refuse collecting trailer consisting of a 7 cubic yard capacity end-tipping body constructed of timber reinforced with steel angle pieces and mounted on a steel channel stepped-up frame. Sliding metal covers are fitted in two sections on each side. The loading height is 4ft., the tipping angle is 45 deg., and the body is tipped by a robust 2½in. diameter telescopic tipping gear with winding mechanism which ensures easy tipping.

Marshall, Sons and Co., Ltd.

The principal exhibits on the stand of Marshall, Sons and Co., Ltd., Gainsborough, will be two road rollers, both driven by oil engines, of 4 tons and 10 tons weight respectively. The latter is illustrated by our Fig. 16.

With the first of these machines we dealt in connection with the Royal Agricultural Show, in our issue of July 1st, 1932, and its characteristics are consequently familiar to our readers. The 10-ton roller, which we illustrate, is driven by a three-cylinder Blackstone compression-ignition engine of 30 B.H.P., which, it is claimed, will effect a saving as regards fuel cost of from 75 to 85 per cent. compared with a petrol engine. The engine is fitted with a decompression device, with the help of which it can be easily started from cold by hand without the use of ignition cartridges or electric hot-wire plugs. From the engine the power is transmitted through two Ferodo-lined clutches that give a forward and reverse effect by means of bevel gears. Thence there is an arrangement of three-speed gears, giving road speeds of 1·25, 1·75 and 3·3 miles per hour. A differential gear is incorporated in the final shaft of the gear-box, which is totally enclosed and filled with oil. The final drive to the road rolls is by a spur gear pinion and an internal gear ring bolted directly to each hind roll. There is a locking arrangement to put the differential gear out of action which can be operated from the driver's station. A foot-operated brake is provided on one of the intermediate shafts, and is so arranged that it does not go out of action while the speed gears are being changed. There is another brake, of the hand screw-down type, acting on the back rolls. Steering is effected by an inclined hand wheel coupled by means of bevel gears to a worm operating a segment connected directly with the steering head. The main frame, it will be seen, takes the form of deep steel plate girders, which are strongly braced together. Between the frames at the back there is a built-in tank, which may be used either for water for spraying purposes, or as an extra fuel tank. The main fuel tank is on the dashboard. The machine is equipped with a scarifier of the Allen type, which can be traversed across the back so as to attack the whole width of the road without it being necessary to turn round the roller. The diameter of the hind rolls is 5ft., and their width 20in. The front rolls are 3ft. 9in. in diameter by 4ft. wide.

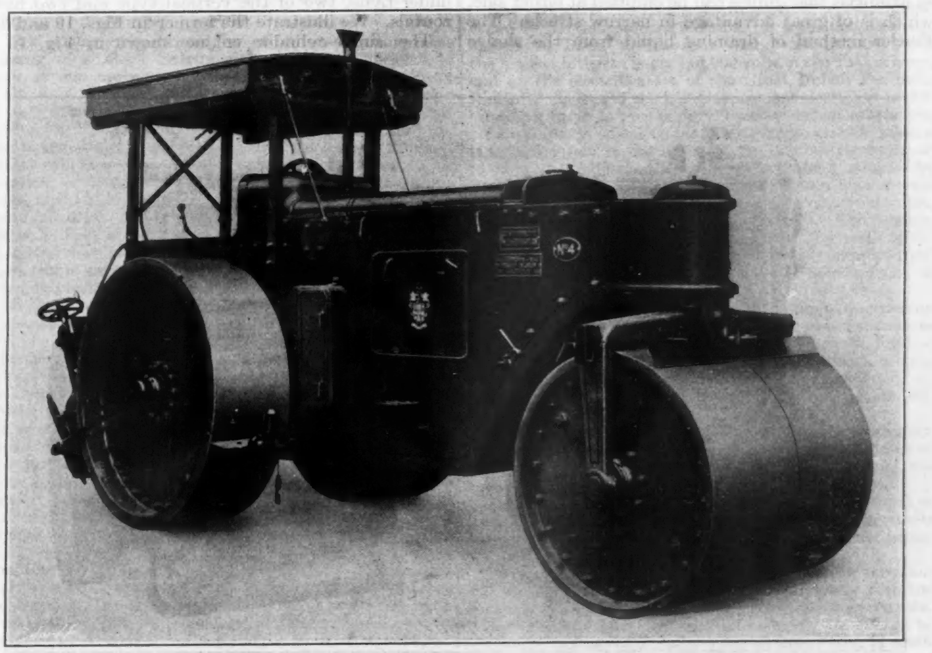

Fig. 16—10-Ton Oil Engine-Driven Road Roller—Marshall

The Lead Wool Company, Ltd.

The name of the Lead Wool Company, with offices and works at Snodland, in Kent, is generally associated with various forms of material for caulking the joints of cast iron pipes, and its stand will have a considerable display of this kind, but such materials are too familiar to engineers to need further description. The air-compressing set illustrated by Fig. 17 is, however, somewhat novel, and is, naturally, associated with the laying of main pipe lines.

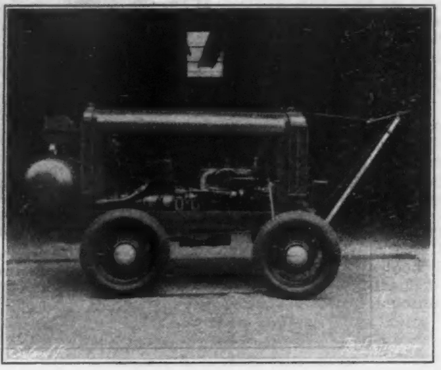
Fig. 17—Portable Compressor—Lead Wool

It comprises two Ford units, one being a four-cylinder engine, with cylinders 3⅞in. diameter by 4¼in. stroke, and the other, to which it is directly connected, a corresponding Ford engine with a special cylinder head which embodies plate valves for the inlet and discharge of the air. This cylinder head is practically the only deviation from standard Ford practice, and, as a consequence, the maintenance of spares for replacement purposes is minimised.

The compressor is capable of delivering 115 cubic feet of free air per minute against a pressure of 100 lb. per square inch, and is separated, as regards the cooling system, from the engine. Each unit has its own cooling system, and so can be worked to the best advantage. The coil ignition system has been dispensed with and a magneto impulse starter fitted for getting easily under way. The engine is equipped with a governor which controls the speed within narrow limits from no load to full load. The complete equipment weighs only 22 cwt., and measures 8ft. 9in. long by 4ft. 6in. high, and has a width, over the wheels, of 4ft.

John Fowler and Co. (Leeds), Ltd.

On the stand of John Fowler and Co. (Leeds), Ltd., will be exhibited an oil-engined road roller and a motor gully emptier, the latter of which is similar to that shown in Fig. 18.

The roller weighs 8 tons and is of an entirely new design. The engine fitted in it is a new Fowler 33 H.P. three-cylinder engine, in which the fuel pump, governor, and, in fact, the entire fuel injection system, is totally enclosed, thus excluding grit and dirt, and thereby reducing wear and tear and liability to stoppages. This system of totally enclosing the important working parts is desirable under any conditions, but particularly in connection with road rollers where dust and grit are present to an exceptional degree. At the same time the method adopted does not interfere with the accessibility. The engine is started by hand, and a special device is fitted for decompression, which operates automatically. The roller is equipped with four road speeds, direct overhead steerage, quick reverse, foot and hand brakes, &c. Both front and rear wheels have steel rims, which assist the roller on gradients and give longer life. Differential gear is fitted, and can be locked from the driver's footplate when there is any tendency to slip. All the controls for the roller are so arranged that they can be operated by the driver from his seat, and special attention has been paid to the driver having a clear view of the road, both from the point of view of the work to be done and passing traffic and pedestrians.

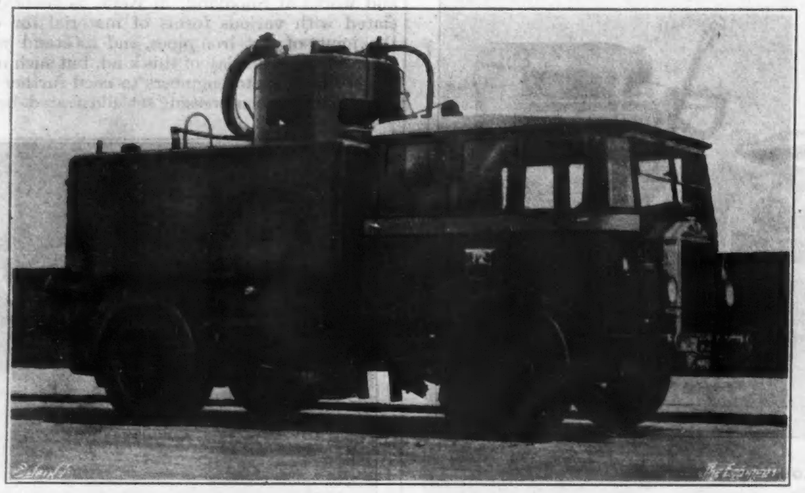
FIG. 18—MOTOR GULLY EMPTIER—FOWLER

The motor gully emptier—see Fig. 18—has been built to the order of the Wakefield Corporation, and is fitted on an "Albion" chassis. It is equipped for gully emptying, street watering, street washing, kerb washing, channel damping, and sewer flushing. It is so arranged that gullies can be emptied at either side, which is of great advantage in narrow streets. The Fowler method of draining liquid from the sludge tank enables a greater number of gullies to be emptied before it is necessary to discharge the refuse, and owing to the large capacity of the tanks, every gully emptied can be sealed with clean water.

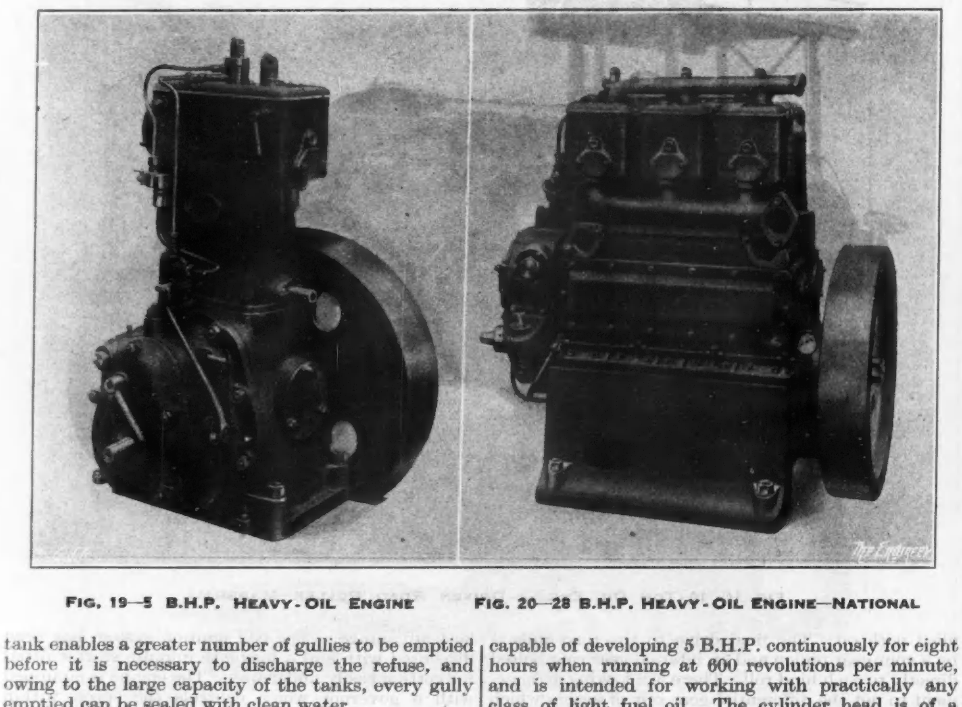
FIG. 19—5 B.H.P. HEAVY-OIL ENGINE FIG. 20—28 B.H.P. HEAVY-OIL ENGINE—NATIONAL

The main tank is totally enclosed, with separate sections for the sludge and resealing water, and is fitted with baffle plates to prevent surging of the water. A vacuum chamber is mounted above the sludge tank, the necessary vacuum being obtained by means of an exhauster driven from the engine gear-box, and controlled from the driver's cab. The contents of the vacuum tank are transferred to the main sludge tank by the opening of an air-tight door operated by a lever from the driver's cab. A vacuum gauge is fitted in a suitable position. The central portion of the main tank forms the sludge tank, and has a floor slope of about 30 deg. towards the rear, where a substantial door is fitted, giving an opening area of 9 square feet. When closed the door is held in position by four clamps. The door is raised by means of a small hand winch and steel wire rope, allowing the refuse to discharge itself by the action of gravity. The clean water tank extends along each side of and under the front end of the sludge tank, providing an adequate supply of water for resealing the gullies after emptying. An independent chamber, separated from the clean water tank, is provided, into which liquid from the sludge tank can overflow through a perforated plate, and be run off as required into the main sewers. To the vacuum tank is attached the suction pipe of armoured hose, with a bore of 4½in. This pipe is supported by a jib crane, balance weights being provided to give easy handling. The suction valve is of a special quick-acting type, giving a full opening of 4½in., and a steel pipe of a length suitable for the gullies in any particular district is fitted to the underside of this valve. The capacity of the sludge tank is 705 gallons, and that of the resealing tank 850 gallons. The engine is of 35–55 horse-power.

THE NATIONAL GAS AND OIL ENGINE COMPANY, LTD.

There will be four oil engines on the stand of the National Gas and Oil Engine Company, Ltd., Ashton-under-Lyne, two of the vertical type and two horizontals. We illustrate the former in Figs. 19 and 20.

The single-cylinder engine shown in Fig. 19 is capable of developing 5 B.H.P. continuously for eight hours when running at 600 revolutions per minute, and is intended for working with practically any class of light fuel oil. The cylinder head is of a special chrome-alloy cast iron and includes a combustion chamber designed to give a maximum turbulence to the incoming charge. This, together with the thorough way in which the fuel is atomised, enables the engine to be started directly from cold without the assistance of preheating devices or compressed air. There is an exhaust valve lifter to ease the effort necessary to turn over the engine at starting. The valves are of the horizontal type, and can be removed without breaking any of the cylinder or pipe joints. Lubrication is effected on the splash principle, and requires about 1 pint of oil for every 40 hours of running. The fuel consumption at full load is 1 gallon per 3¾ hours. The weight of the engine without its fly-wheel is 4 cwt.

The larger vertical engine—see Fig. 20—is of the three-cylinder type, and is capable of developing from 22½ to 28 B.H.P. at speeds of from 800 to 1000 revolutions per minute. It can, however, be run at even higher speeds, with a corresponding increase of output, if it is equipped with special alloy pistons. The cylinders have renewable liners, and are of similar design to those of the smaller engine just described. The lubrication is of the forced feed type, and has an auto-cleaning strainer in the oil service. By rotating the inner member of this strainer, foreign matter is scraped off and falls into a sump, from which it can be easily removed. The fuel atomisers are of a self-cleaning type, and have no small holes liable to become clogged. The engine weighs 14½ cwt., and its cyclic variation is said to be 1 in 120.

Both the horizontal engines are of the single-cylinder type, with enclosed connecting-rods and splash lubrication. One of them will develop 26½ maximum brake horse-power when running at 320 revolutions per minute, and the other from 10 to 11 B.H.P. at 600 revolutions per minute. They have cylinders similar in general design to those of the vertical sets, but the smaller engine is equipped with a cartridge arrangement, so that it can be started in conditions of extreme cold.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ROAD ACCIDENTS.

SIR,—The leading article in the issue of October 27th on "Road Accidents" will, I believe, be regarded by many as somewhat inadequate to the urgency of the problem. It is said that time has not yet been given for the provisions of the Road Act to take full effect, or for those effects to be measurable, notwithstanding that the figures for the fatalities and injuries are still much the same as previous to the Act. In the four years ending 1932, no less than 26,659 have been killed and 707,371 injured on the roads. This fifth year will possibly bring the totals to 34,000, and a little short of a million respectively. Stupendous figures, utterly incredible twenty years ago.

Your readers are warned to avoid the risk of action which may prove too drastic. The 1930 Act sought to remedy a progressively evil state of affairs and was the result of some years cogitation. In five or more years of taking thought our statesmen have accomplished so little as to be indiscernible. I and others begin to fear that the matter may be taken out of their hands and a wave of ruthless indignation will suppress the intolerable nuisance which motor traffic has developed into.

When posterity reads in imperishable records of platinum and gold that we could only sigh and wring our hands before the monster which engineers had created, and whose appetite demanded the annual sacrifice of 6000 lives and the torture of some 200,000 more, they must surely brand our civilisation as the most futile and callous throughout the ages. It may be that they will be curious to learn what happened to the engineers; did they get away with it scot-free, or did they get what should have been coming to them?

It is an extraordinary fact that those who drive the deadly machines and the general public too, are still quite unaware of the magnitude of the slaughter, notwithstanding the amount of publicity given to it. I found this statement on a prolonged investigation made personally two years ago, and frequently checked since then. It is known in a general sense that a lot of people are killed and injured, but the highest guess out of more than 200 taken from people in all sorts and conditions of life has been 1200 killed, 9000 injured. The usual guesses were about 800 and 1700 respectively. The correct figures were given by two persons only, one an engineer.

I have been assured by one who is highly skilled in mathematics that the actual figures, though so immense and possibly because of their immensity, convey no specific impress to his imagination. This may explain why they have little or no effect upon the generality.

My investigations led to a very definite conclusion that excessive speed is the primary cause of the trouble. The limitations of a pedestrian's ability to observe, to estimate distance, and the impossibility of estimating the speed of an approaching vehicle are secondary causes which are nevertheless of primary importance, because they are limitations imposed by Nature and unchangeable.

A subconscious sense of superior force or invulnerability, combined with a hurrying and impatient optimism is the foundation of the desire for high speed. It is not a matter of necessity.

When I drive I find that I readily succumb to temptation and take chances which would be difficult to justify. But everybody keeps clear of a Scammell lorry, as a driver of one smilingly assured me, and all progress after the manner of Agag when passing a drove of cattle or a bunch of horses.

Engineers have put into the hands of the wholly and incorrigibly ignorant a machine every bit as dangerous as a loaded gun at full cock, and they have assured them that it can be controlled to a degree and in a manner which violate fundamental laws and are impossible.

Having raised this terrible demon, it seems to be up to engineers to provide its efficient control, and to inform Government in no uncertain voice that they can do so provided that a very small minority of the population are made to forego some of the pleasure and profit which has been acquired by an unfair and appallingly cruel exploitation of the generous tolerance of their fellow-countrymen. R. J. N. Willcox.

Wimborne, November 1st.

[We fear our correspondent has missed the real point of our article. It was that full details and statistics of accidents should be collected by some authority and be carefully analysed. When that had been done, we should be in a better position to formulate new legislation if it were called for. It is now understood that the Ministry of Transport is analysing the road accident returns.—Ed. The E.]

PREVENTABLE WASTE IN BUSINESS.

Sir,—A recent striking address on "Waste in Manufacture" directed attention to losses of a spectacular extent, losses which, to remedy, call for something like revolution. But what of the smaller leakages, unobserved because inconspicuous, yet throughout the year creating a very formidable total ? Here is a brief survey of small-looking, every-day things which may well repay consideration.

Commencing with administration and the board of directors, when a business expands and combinations are effected, there is an ever-present danger that directors get preoccupied with the general to the neglect of the particular. When that happens, decisions in their own firms may be delayed, or, worse, made hastily and followed by bad results, perhaps widespreading and lasting. Additional burdens cannot be taken on efficiently unless arrangements are made to keep the old duties well maintained.

Lack of financial budgeting for the approaching year may cause very serious loss, and, at times, consternation. Departmental budgets, although necessarily elastic, are a real protection against financial trouble. Indefinite responsibility gives rise to carelessness or indifference, with the natural consequences. On the contrary, when localised, and reasonable freedom is allowed, initiative is encouraged and efficiency increased. An inefficient or over-pressed department is sometimes answerable for a running loss, continuing until its reorganisation. This particularly affects the cost system, which, if inaccurate, inadequate, or dilatory, places the firm in constant danger.

In the offices—assuming them organised for the firm's requirements—there are possible leakages which, being cumulative, make up an objectionable total. Collection of statistics may be interesting, but are they all used ? It is not even enough that they are useful. All knowledge has potential value, but is only of real value when used. Then what a slack time the typists generally have in the earlier hours, a corrective being special duties or a dictating machine where circumstances—and the dictator—are suitable. Again, verbose and unnecessary correspondence. It has been said that no business letter costs less than a shilling. A large proportion of matters from some departments can be printed on post cards, or, if desired, in facsimile typing.

Small illnesses, colds and headaches, play their adverse part, and are often attributable to office conditions such as poor ventilation, bad lighting, and unclean telephones. It is not unreasonable, but certainly not general, for telephones to be disinfected every morning.

In still another direction are losses possible in unpunctual payment of monthly accounts, meaning discounts forfeited, credit impaired, and service from suppliers without enthusiasm.

It is, however, in the works that there are numberless rivulets which carry off money at an alarming rate unless constantly watched. Defective working conditions, bad lighting, poor heating, draughty shops, avoidable overtime, change or turnover of labour (it always costs something to train even a skilled man into a fresh job), excessive or insufficient machining allowance on details, want of precision in orders, verbal orders, lack of planning and of a monthly or weekly programme, absence of team work between dependent departments, inadequate internal transport facilities and different floor levels, power shortage, belting improperly attended to or used in too short drives, insufficient or inadequate tools for maintenance and outdoor staffs (whose wages and expenses are high and should be reduced by good labour-saving appliances), supplies not in stores when wanted, uncalled-for stock in stores representing dead money and probably quite usable if the right steps are taken about it.

Any of these things can, of course, happen occasionally in the most carefully managed works, but it is wise to see that they are not repeated often enough to become habitual. Robert True.

Bedford, November 6th.

COAL–OIL–GAS.

Sir,—In the controversy raging between the partizans of coal and oil, are we not "missing the wood for the trees" ? That our fleet and our fast liners must burn oil under their boilers is a question of expediency and is certainly not economical ; that sufficient oil for the fleet should be, if possible, synthetically prepared from home sources is, therefore, sound ; but that either hydrogenation or other process is warranted for the supply of a national and general purpose liquid fuel, its cost alone denies.

The importance of restoring our coal industry is, however, paramount, and if the report is true that Rotherham is hoping to put gas with a thermal value of 500 B.Th.U. on the market at 10d. per 1000 cubic feet, it means that gas power is available at practically the same cost as oil power, and gas is a direct and simple product from coal—in fact, it is the essence of coal power.

One understands, further, that the experiments in the use of compressed gas for road vehicles in place of petrol are proving highly successful, and, given a sufficient demand and the erection of gasworks at the pithead of collieries supplying suitable coals, and eventually a gas grid to feed important centres, it is probable that high-pressure gas could be sold after a period of development at a competitive figure with imported heavy oil, and far cheaper than synthetic oil, to the immense benefit of our coal industry.

Such gas would be suitable for road and rail traction, for short voyage aeroplane services, cross-Channel and coastal cargo and passenger ships fitted with gas engines, land drainage and water supplies, and for bringing the facilities of light, heat and power to outlying districts and villages not touched by the "grid," a storage shed for the containers and a weekly lorry service being all that would be required.

It is held that public works are not economically sound, though it is hard to understand this argument, where such works would save the dole and ensure the indigenous fuel resources of the country being efficiently developed. With our locked-up wealth and our millions needing work—in a nutshell, why not a National Gas Scheme ? It is our natural and modern form of indigenous power as surely as water power is that of Italy or Switzerland. And its full development would do much to put the country back to work and to restore our basic industries.

London, S.W.7, November 1st. S. P. Christie.

WATER LOWERING IN QUICKSANDS.

Sir,—Mr. Reed Cooper deserves thanks for drawing attention to the unwarranted claim of novelty made by foreign interests for a system of lowering underground water by pumping from a bore-hole. That this claim, so easily believed, apparently, by the Southern Railway authorities, should have been accepted as an adequate reason for the importation of foreign machinery is a matter difficult to understand.

Where there is so much professional knowledge idle at present, it seems a pity that civil engineers should not call in specialist opinion of British nationality when difficulties occur out of their experience. At least they would get disinterested advice and thus avoid any questioning of their desire to help home industries.

Waterworks Engineer.

November 7th.

The Little Salkeld Collision.

The incorrect performance of a simple duty—the turning of a block instrument switch from *through* to *open* at one movement instead of first to the midway position of *intermediate*—was the cause of the collision of July 10th at Little Salkeld, on the Settle and Carlisle section of the London, Midland and Scottish Railway. Many signal-boxes are closed at night or on Sunday, whilst others are open only when vehicles have to be attached or detached. Little Salkeld is one of the latter class, and, except under the conditions named, block communication is between Lazonby, 3 miles north of Little Salkeld and Langwathby, 1⅝ miles to its south. In order that vehicles may be attached to or detached from trains as may be required, the points in the main line have suitably to be moved, and that has, of course, to be done under the protection of the main line signals. Those signals stand at "clear" when the box is closed, and the interlocking compels them to be placed to the "danger" condition before the points are moved.

Porter-signalman Hannah at Little Salkeld went to his dinner at 12.30 noon and got back to the station at 12.55. At 1.8 a down freight train arrived which had a wagon of coal to detach, and to be placed in the siding on the up side. That necessitated setting back the engine and three wagons through the crossover-road from the down main to the up main line, previously to which the signals had to be put to "danger." Hannah should first have turned the switching-out instrument from *through* to *intermediate*, and had he done so his up line block instrument from Lazonby would have changed from *line blocked* to *train on line*, and he would have known that a train—the 12.44 express from Carlisle—was in the section. Instead of that, he moved the switch right over to *open*, put the signals to "danger," and opened the points. The driver of the freight train at once began to set back. Unfortunately, the express was so near that it had already passed the distant signal. That signal was 745 yards from the home signal, and its aspect was such as to intimate to the driver that he had a clear road through the station, and he approached at a speed of about 60 m.p.h., preparatory to climbing the 30 miles to Ais Gill summit, with a view of only 360 yards of the home signal. The results of the collision were less serious than might have been expected, as the only fatality was to the unfortunate driver of the freight train. The accident was inquired into by Lieut.-Colonel Mount, whose report was published on November 3rd. That document is dated August 18th, but its issue has, in accordance with the usual practice, been delayed until the criminal proceedings brought against the man were over ; otherwise, Colonel Mount's opinions might have been used in evidence against the man. Those opinions are that the man failed, in the first place, to telephone, in accordance with the regulations, to ascertain what trains, if any, were in the section. In the second place, he failed to notice the condition of his block instrument to Langwathby. On turning the switch at one operation to *open* his Lazonby instrument would at once go to *line blocked*, but, as the indications on block instruments can only be changed by the man in advance, that on his up line Langwathby instrument would not be affected, and it would continue to show *train on line*. Hannah's duty in that case, if, as he thought, the express had passed, would have been to wait until Langwathby had sent the train-out-of-section block signal. Such irregularities prompt inquiries as to the training of the man for his duties. In that relation mention must be made of the practice—introduced long before the war—of making a station-master responsible for more than one station. Little Salkeld, thus, came under the control of the man at Langwathby. It becomes increasingly necessary, therefore, Colonel Mount observes, to employ, particularly on main lines, only men of character who can be implicitly relied upon. Hannah was not really fitted for main line operation, and certainly proved that he was not competent to hold the position which he occupied.

In concluding his report, Colonel Mount says : "It speaks well for the extreme care which is generally exercised by signalmen, and the fact that this isolated failure, on the part of one man, who seems to have lost his head, has taken place, in no way suggests that there is any laxity or weakening in discipline with which the company cannot adequately deal." Equally gratifying is the earlier remark of the inspecting officer that he has no recommendations to make. That means that no changes in signalling are advised.

Another aspect of the accident must be noticed, particularly as it is of a complimentary character. We refer to the behaviour of rolling stock. The second coach on the express was an all-steel eight-wheeled bogie corridor third brake. Colonel Mount says of this vehicle that, although it was badly ripped on the off-side and its front end was thus crumpled, it clearly illustrated the strength of all-steel construction. Generally, it may be said that the stock throughout the train withstood the impact well, as all the six bogie vehicles, except the fifth—which was a London and North-Western composite—were fitted with shock-absorbing buffers.

Mandi Hydro-Electric Project.

A description of this project was given in The Engineer of Friday, March 3rd, 1933.

The possibility of the Uhl River, a tributary of the Bear, as a source of hydro-electric power, was first envisaged by Mr. J. W. Meares, C.I.E., some time Electric Adviser to the Government of India, and was later confirmed by Mr. R. N. Aylward in his hydro-electric survey of the Panjab. The bold vision of Sir Malcolm Hailey, Governor of the Panjab, brought the scheme within the region of practical possibility, and it remained for the energy and resourcefulness of Colonel Battye to carry this great project through.

It was Colonel Battye's unswerving faith and his indefatigable advocacy which helped to maintain the scheme in the days of carping criticism, when public feeling had been unnerved by the immensity of the venture and the cost of the undertaking.

Colonel Battye died, the result of a motor accident, at the verge of the fulfilment of his labours.

The project is the largest hydro-electric scheme undertaken by the Government of India. It is the first electrical system in India to transmit energy at 132,000 volts, the highest hitherto being 110,000 volts in the Tata scheme, and on the electrification of the Great Indian Peninsula Railway. It is also the first Government electricity undertaking in India to give supply direct to urban consumers.

The primary object of the Mandi hydro-electric scheme is to give effect to the desire of the Panjab Government to help the industrial development of the provinces by providing a plentiful supply of cheap power, over a wide area. The Panjab possesses no coal of commercial value, and coal has to be imported from Bengal. The scheme, when fully completed, will not only meet the needs of the industrial and urban consumers, but will supply rural areas, with particular reference to the development of agriculture.

The scheme includes a double circuit trunk transmission line operating at 132,000 volts from the power station at Jogendenagar to Lahore, 173 miles, and branch lines to important towns. In as many as thirteen towns, a complete system of local distribution is being provided, by which a direct retail supply will be given, which will eventually be extended to other towns.

A bulk supply to the Kapurthala State is under negotiation, and supply will eventually extend to the States of Faridkot, Malerkotla, and Nabha. Under terms of the agreement, a supply will be given to the Mandi State.

The supply of electricity will be eventually extended to rural areas for pumping water for irrigation in tracts outside canal influence ; for the relief of water-logged areas, and possibly for farming operations.

The supply for industries and agricultural purposes will be offered on a tariff that will vary inversely with the demand. The greater the consumption, the lower the rate.

For domestic purposes an "all-in tariff" is offered to encourage the use of electricity for all home uses, in addition to light and fans. That is a single set of wiring and one meter will only be necessary in each house.

The year ending on December 31st, 1933, is the period laid down by Parliament for the admission of architects to the Statutory Register created by the Act of 1931. It is already clear that the movement has been a great success. It has been an immense task to deal in so short a period with thousands of applications, every one of which had to be carefully scrutinised by an expert committee and approved by the Registration Council. The great majority of the members of the R.I.B.A. have already applied and the names on the Register are a striking indication of the way in which the leading men in the profession are supporting the movement.

Kinematic Design in Engineering.*

By Professor A. F. C. POLLARD.

PERHAPS the most fundamental and yet simplest of conceptions in engineering is that of the kinematic chain. It took shape in men's minds after much laboured thought and was first clearly enunciated by Reuleaux as the kinematic chain of mechanism with one link fixed, but later it was generalised by Koenig as an assembly of mutually coupled resistant bodies.

The kinematic chain therefore is to be regarded as composed of two distinct parts, the links and the couplings which connect the links together. The design of the links involves the greater part of machine design, and has received much attention, but the design of the couplings has in a sense been neglected, and it is my intention to discuss this side of design in the light of an important kinematical theorem.

A coupling between any two links will either fix the links or permit them to move relative to one another. In mechanism the majority of the couplings consist of the three simple and lower closed pairs: the turning pair, the sliding pair, and the screw pair, the latter being a generalised form from which the two former are derived. The elements of these lower pairs envelop one another, the brasses, for example, envelop the journal or the nut envelops the screw spindle, and these elements are integral with the connected links.

In this way the elements possess large mating or functional surfaces capable of resisting heavy pressures, and under certain circumstances they can be made air or steam-tight. In addition to resisting heavy pressures, an equally important consideration is that the enveloping elements can be designed to hold films of oil, thereby reducing the friction and wear to a minimum during relative motion.

Apart from the advantage of holding oil, however, the elements of a pair must have a certain small clearance between them in order that relative motion may be possible. This clearance cannot be reduced below certain practical limits if the elements are to move relative to one another without undue friction, since it is only possible to make surfaces within certain limits of perfection of geometrical form and to within certain limits of mating dimensions.

This imperfection of fit between the elements of the lower pairs introduces aberrations in the relative movement of the two links, and the relative motion of the first and last links of a chain will suffer from the algebraic sum of these aberrations. Although these aberrations are too small to matter for heavy-duty mechanisms, such as machines, whose function is to transmit power rather than geometrically exact motion, they introduce into light-duty mechanisms, such as scientific indicating instruments, serious imperfections of the instrument readings and other troubles which disturb their behaviour in an unsuspected manner.

A number of factors contribute to the imperfection of geometrical form during manufacture. In planing and turning operations, the spring of the tool and of the machine itself causes irregularities on the machined surface when the tool encounters a variation of surface hardness in the metal, and unless great care is taken the feed of the tool invariably produces extremely shallow grooves. These grooves can be very easily seen on an arbor which has been subjected to long use, and in some arbors a kind of spiral arrangement of surface irregularities is visible, which is due to a complicated state of vibration set up between the tool and work.

In grinding operations other irregularities make their appearance, and in plane as well as cylindrical works these take the form of a number of small flats, regularly arranged and mostly perpendicular to the travel of the wheel's surface. These flats sometimes produce remarkable patterns, and whatever may be the theory of their production, their regularity suggests vibration, produced in some way, as the cause.

All such irregularities of the surface can be reduced by lapping and polishing processes, but these processes will not eliminate and frequently enhance the production of pseudo-cylindrical and pseudo-spherical forms. In these the diameters are constant, but they depart from geometrically circular and spherical figures. This departure from true geometrical form cannot be detected by measurement between the parallel anvils of a measuring machine, which merely indicates the length of a diameter.

The manufacture of truly flat surfaces is not so difficult. The well-known method of producing fairly good flat surfaces was originally devised by Sir Joseph Whitworth, and consists in taking three surfaces and lapping them together in consecutive pairs. To produce flat surfaces which are optically perfect, however, requires special skill and is a costly process. To produce optically flat parallel surfaces is very much more difficult.

The truth of a plane lapped and polished surface can at once be checked by placing upon it a glass proof plane which is a true optical flat and which itself has been shown to be truly flat by checking against two other flats in consecutive pairing. When light falls upon the two opposed surfaces, interference bands are seen if the surfaces form a very small angle with one another, and any divergence of the metal surface from flatness is shown by a want of straightness and parallelism of the interference bands. In this way the actual divergence of a flat surface from an optical flat can be measured in terms of the wavelength of light. There is no such simple way of measuring the truth of circular form in cylinders or the spherical form in spheres, without the costly construction of special cylindrical or spherical proof plates in glass for each diameter manufactured. It requires elaborate interferometric arrangements to carry out such measurements for all diameters.

The most difficult surfaces of the lower pairs to produce are undoubtedly the helicoidal surfaces of screw threads. No systematic method has yet been developed which will produce an optically perfect screw spindle, and no method of checking the perfection of the helicoidal surfaces, which are ruled surfaces, similar to the methods used for cylinders and spheres, has yet been devised.

In instrument and other precision mechanisms the aberrations of the link motions due to these constructional imperfections of the couplings can be fully revealed by setting them in action slowly forwards and backwards over their complete range of movement.

For example, suppose that an indicating comparator, a voltmeter, or a weighing machine, is taken aperiodically in one direction through the range of its indications which are observed at intervals against the measured quantity, and the same operation is repeated in the opposite direction through the range of indications back to the initial value, great care being taken that the indicator never moves momentarily backwards. Then it will be found that if the indications are plotted against the measured quantity the two curves thus obtained will never coincide, but in general will form a loop, which is termed the hysteresis loop of the mechanism. The hysteresis loop, having force and displacement co-ordinates, has the characteristics of a work diagram and represents in fact a loss of energy which is localised at the couplings of the links or members constituting the kinematic chain of the instrument mechanism, and in the imperfect elastic deformation of spring members. Generally speaking, this energy is converted into heat and dissipated by radiation, and more often than is suspected, part of it may appear as electric potential.

Since the greater part of the variance in precision light-duty mechanisms is traceable to the clearances between the functional surfaces of the couplings, evidently the object of improved design is to eliminate these clearances. But, as previously indicated, on account of the increasing difficulties of manufacture as perfection of form in the functional surfaces is approached, there is a practical lower limit to the amount of clearance between functional surfaces which envelop one another.

We are therefore led to inquire how much of the enveloping surface of a coupling may be removed without interfering with its restraint upon the other element of the paired links. The restraint in all cases is equivalent to a system of forces acting in place of the enveloping surface upon the other element of the coupling, and this system of forces prevent all motions of the one link relative to the other except that particular motion permitted by the coupling.

Imagine one link fixed in space and the other not connected to it in any way but free to move in any manner. Let three mutually perpendicular axes x, y, z be drawn through any point of the fixed link. Then any motion whatever of the movable link may be resolved into a rotation about an axis and a translation about that axis much in the same way as a nut moves on a screw spindle, and this mode of constructing the displacement is called a "screw." This "screw" can now be resolved into three component translations parallel to the axes x, y, z, and three component rotations about them.

It is evident then that the movable link can have six different ways of moving relatively to the fixed link; that is to say, it has six degrees of freedom. We are thus led to the important kinematical theorem that "a rigid body has six degrees of freedom," and we shall see that the correct application of this theorem to the design of couplings presents remarkable advantages that can be gained in no other way, the most important of which, from the constructional point of view, being the entire elimination of manufacturing limits. To fix the moving link relative to the fixed link, these possible motions about the axes must be prevented by the system of forces properly applied between the elements of the links.

It must now be obvious that if the movable link makes contact with a surface of the fixed link at a point, say, with the surface $x=0$, a translation parallel to x is prevented and the movable link is robbed of one degree of freedom. It is easy to see that every additional and properly chosen constraint, produced by contact of a point of the movable link with a surface of the fixed link, will reduce the relative motion of the two links by one degree of freedom. It will thus require five constraints properly chosen to give the single degree of freedom of the lower pairs and six constraints to fix one link relative to the other.

A proposition of the greatest importance to the design of instrument mechanisms and, indeed, to the design of any mechanism whatever, immediately follows from the kinematical theorem. It is this: If the constraints between two members exceed six, the members will suffer unnecessary elastic deformation. For if the two members are relatively fixed by six constraints, it will require forcible contact or the most exacting workmanship at a given temperature to enable a seventh constraint to be introduced.

The application of this almost self-evident kinematical theorem to the design of couplings in instrument mechanisms was insisted upon by Kelvin and advocated by Clerk Maxwell. A number of beautifully simple examples are to be seen in Kelvin's instruments, but though he states that he was taught these principles by the eminent mechanician Professor Robert Willis, no earlier applications of the theorem of any importance are to be found. It is, indeed, strange that only within recent years has kinematical design found its way into instrument manufacture, and this advance is chiefly due to the insight of the late Sir Horace Darwin, M.I. Mech. E., who was head of the Cambridge Instrument Company.

Couplings with No Degrees of Freedom.[1]—These comprise "fixtures" or "clamps" in which it is intended that the two members shall be securely locked together without unnecessary elastic deformation. The commonest example may be found in the theodolite. In this instrument the levelling screws of the tribrach terminate in balls which rest on or are forced into contact with, by means of a locking plate, the six surfaces of three right-angled grooves cut in the base at 120 deg. with one another. Frequently, however, this design is misapplied and the feet fit cylindrical grooves which partly envelop the ball. By splitting the metal and drawing the two halves of the groove together with a clamping screw the ball feet can be held. To level the instrument the feet must be unclamped, and then the ball of each foot has only one indeterminate contact on the bottom of its mating groove. The instrument, in consequence, has at least, if not more than, three degrees of minute freedom; it has no definite position relative to the base, and the act of clamping the feet may throw it out of level. These inconveniences can only be minimised by careful fitting, and it is the chief characteristic of correct kinematical design that careful fitting is not required. The American system of using four levelling screws for theodolites is definitely wrong, kinematically and in practice. If the screws are tightened up too much it is possible to distort the main socket of the centres, and numbers of instruments are damaged in this way every year. The base of Casella's railway transit theodolite has Kelvin's hole, slot, and plane seatings for the spherically ended feet, and this arrangement of the surfaces in the coupling element has an important advantage over the three grooves spaced at 120 deg.

In the lower element of the Kelvin coupling a trihedral hollow is cut with three plane orthogonal surfaces. In line with the hollow a right-angled groove with two plane surfaces is formed. The sixth surface is the horizontal plane surface of the element. The three spherical surfaces of the mating element make contact with the surfaces of the hollow, the groove, and the plane respectively at different levels. The advantage of this form is that it is impossible to put any but the proper foot into the hole without detecting the mistake.

A trihedral hollow can be easily punched in the softer metals, but cannot be so formed in cast iron. It is a simpler matter to cut a conical recess, and this modification of the hollow is frequently used. But the use of a conical hole may lead to a possible violation of the kinematical principle.

The possibility of designing a coupling so that two members may be relatively fixed without undue elastic deformation should appeal to engineers, and it is interesting to note that the practice of fixing the engine and gear-box unit, in motor car construction, to the unavoidably flexible chassis by three or four points of support is increasing. In some well-known makes of car the engine is mounted at one point on either side in front and the third point is situated at the rear of the gear-box casing. The significant point about these methods of supporting the engine unit is that motor car engineers are realising that the old method of bolting the engine unit to the frame at any number of points is unsatisfactory. The unevenness of the road causes variable elastic deformation of the frame, and it is bad practice to mount the engine unit so that it tends to resist the frame shifts. Moreover, though the design of the engine aims at as perfect a balance of reciprocating parts as possible, the design of the mountings strives to secure smooth running by permitting the engine unit to rock slightly relative to the frame, in a controlled manner.

Couplings with One Degree of Freedom: (1) *Trans-*

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* The Institution of Mechanical Engineers; the twentieth Thomas Hawksley Lecture.—Abstract.

[1] Under this and each subsequent similar heading Professor Pollard described and illustrated specific examples, drawn from practice, of the types of coupling mentioned.—Ed. The E.

lational Couplings or Slides.—The manufacture of precision dovetail slides or, indeed, any other form such as tongue slides, is notoriously costly, since not only must the limits on the elementary functional surfaces be checked by limit gauges during manufacture, but the possible want of parallelism of the surfaces which may develop during manufacture must be checked by functional gauges. Moreover, in the design of the usual heavy engineering slide, it is difficult to generate planes of precision without constructing the female member of several pieces. These pieces have to be assembled by screws, the tightening of which may very easily distort the plane surfaces.

As the clearances are diminished the friction is increased, which completely upsets the performance of some delicate mechanisms. The friction, for example, in the fine adjustment slide of microscopes introduces marked variance into the micrometrical movement. To overcome these imperfections in the fine adjustment mechanism of their microscopes, Messrs. Leitz have introduced a kinematic ball-bearing slide with very satisfactory results. One of the simplest forms of kinematical slide is a cylinder sliding on the four surfaces of two "V's" with an arm integral with the cylinder ending in a point which makes contact with a plane parallel to the axis of the cylinder. This latter constraint prevents rotation of the cylinder upon its V supports; if the plane is inclined to the axis of the cylinder the motion will not be a translation, but a screw. The geometrical perfection of the motion, therefore, will depend upon the correct setting of this plane, its truth as to flatness, and the geometrical perfection of the cylinder. It is a simpler matter to fulfil these conditions than to make an equally perfect sliding pair with enveloping surfaces. In kinematical couplings the geometrical perfection of the relative motions depends only upon the perfection of the geometrical forms of the guiding surface, and not upon their dimensions or closeness of fit with other surfaces, and this is an advantage of the greatest importance to economic manufacture.

In mechanisms which require the sliding friction to be a minimum, the five necessary constraints can be replaced by rolling balls, and the first design of this kind was made by Mr. William Taylor in 1915, when he devised a screw gauge measuring machine for the Screw Gauge Department of the Ministry of Munitions. The micrometer holder slides kinematically on an intermediate member—the carriage—which also slides kinematically on the frame, the two slides being at right angles to one another and similar in design. In the cast iron frame two right-angled parallel grooves are cut, and in the carriage there is a similar groove and a flat at the bottom of a groove. Two balls rest in one groove in the frame and a third ball in the other. When the carriage is placed on these, the two balls make contact with the two surfaces of the V-groove and the third ball with the flat. So the carriage has four contacts with the two balls and one with the third ball, constituting the five necessary constraints, and is therefore restrained to move parallel to the two opposed grooves, whereas the flat permits the ball in its opposing groove to take up a position of repose.

In measuring machines requiring greater accuracy, the plane surfaces of the grooves may be replaced by the surfaces of accurately ground hardened cylinders suitably supported, so as not to bend under load and placed side by side in pairs, so that the tangent planes at the points of contact with the balls form an angle of 90 deg. Such a design of a ball-bearing slide is well shown in the universal gauge measuring machine made by Messrs. A. C. Wickman, of Coventry.

The strict application of the kinematical theorem to the design of the ball-bearing slide permits the use of three balls only, two in the groove giving four constraints, and one on the flat giving the fifth. If the number of balls is increased, then the theorem is violated, and, as in the fit of functional surfaces, precise workmanship becomes necessary and the sizes of the balls must be the same within very small limits. Otherwise, as in the construction of ball bearings, only those balls required by the theorem will take the load and the others might as well be absent.

When the moving member has to travel long distances along the slideways, balls are inconvenient, since they travel with less speed than the moving member, and may become sufficiently displaced in a long run to cause instability of the moving member. In such cases the ball constraints may very conveniently be replaced by rotary ball bearings fitted to the moving member. When ordinary rotary ball bearings are used in this way they must be carefully fitted if their outside cylindrical surfaces are to make line contact with the plane surface of the ways. But such practice is contrary to the principles of kinematic design, one of the chief characteristics of which is that functional fitting between the elements of the couplings is not necessary. The conditions of the theorem, however, can be satisfied and all exact fittings of the rollers eliminated by grinding the outside cylindrical surface of the ball bearings to a spherical form of large radius, or, if line contact is desired, by using bearings, which, having ball races of spherical form, will make line contact automatically.

(2) *Rotary Couplings.*—In certain optical instruments the accuracy of their readings depends upon the accuracy with which a member rotates with reference to a divided circle. If the axis of rotation of the member, which carries an indicator, such as a vernier, does not exactly coincide with the centre of the divided circle, errors of excentricity are introduced into the readings. Though such errors of excentricity can be eliminated by taking the mean readings at the two ends of a diameter, this cannot be done when the divided scale is not a whole circle, such as in sextants. In such instruments the greatest care must be taken in constructing the axes.

These axes are generally constructed as complete journals which are liable to introduce indeterminate errors of reading, apart from excentricity errors, due to the necessary clearances between the functional surfaces. In theodolites, for example, the greatest care is taken to reduce these clearances to a minimum and yet at the same time permit smooth movement, by constructing the axes as slightly tapered cones with end restraint. Though many manufacturers lap the two components of these axes together, this cannot be done with precision, since a conical surface has variable curvature along its length. Apart from the danger of producing rings on the lapped surfaces, there is the greater danger of driving the abrasive into the surfaces, which will subsequently damage the bearing during use. A simple manner in which these objections and constructional difficulties may be met is suggested by the design of a rotary coupling for the grating table of a 21ft. grating spectrograph at present being designed and constructed at the Imperial College of Science and Technology, South Kensington. A shallow steel cylinder of large diameter is lapped on its upper surface, the central portion being removed by recessing, into a precision plane and its cylindrical surface is ground and lapped to as true a cylinder as possible, its exact diameter being of no consequence. The grating table is coupled to this cylinder by three plugs of gun-metal 120 deg. apart fitted to the table with a gentle force fit and making contact with the plane surface of the cylinder, whilst two plugs tapped with a fine thread into the table are in contact with the cylindrical surface of the cylinder, also at 120 deg. apart. On the opposite side of these two plugs and bisecting the angle between them, a spring-controlled plug is fitted with an easy sliding fit to the table. The spring is sufficiently powerful always to maintain contact between the constraints provided by the two plugs and the cylindrical surface of the cylinder. The necessary clearance in the sliding fit of the spring-controlled plug cannot be detrimental to the precise movement of the coupling, since the only function of this plug is that of force closure. Contact at the three constraints on the plane surface of the cylinder is secured by the pull of a central screw acting on a spring washer and thrust ball bearing.

As with slides, the sliding constraints in rotary couplings can be replaced with steel balls in order to reduce the friction. The ordinary ball bearing in which the balls make contact with grooves, the radius of which is a little greater than that of the balls, is a coupling of four degrees of freedom. Kinematically, the function of the bearing is not changed in any way if all the balls are removed except three set 120 deg. apart. Two of these act as the kinematic constraints, whilst the third introduces the necessary pressure to maintain these constraints. So the bearing is equivalent to a coupling with two constraints. Each ball makes contact at one point in the grooves, but on account of the depth of the grooves the possible rotations about axes perpendicular to the axis of their common plane are very small and the end movement is very slight, but nevertheless it is not strictly constrained. These three slight degrees of freedom together with the intended rotation make up the four degrees of freedom. In order, therefore, to ensure that an axle shall have strictly one degree of rotation it is necessary to mount it in two ball bearings and to prevent the minute end-play with a thrust bearing.

(3) *Screw Couplings.*—The degree of freedom to perform screw motion is of the most general character, for it consists of motion parallel to an axis compounded with a rotation about the axis in fixed proportion to the axial translation, leaving every other motion free. The helicoidal surfaces of practice form the screw thread which is generally complicated by the unnecessary contact of root and crest radii. The helicoidal surface is the most difficult elementary surface in mechanism to generate, and the screw couplings of instruments should be stripped of unnecessary complications which, however, may be necessary in heavy engineering to transmit heavy loads or pressures. The construction of the precision screw coupling should be concentrated upon the production of precision helicoidal surfaces only, and the radii of crest and root should clear. In practice the five constraints for screw spindles with V threads can best be secured by the functional contact of four suitably located portions of the fixed nut.

The seating of a screw spindle designed in this manner, which was first pointed out by R. S. Whipple, is constructed by casting white metal around the accurate screw spindle and then splitting it in half. The lower portion fixed to the framework of the instrument has the thread cleared away except at four parts, corresponding to the four constraining surfaces of a rotary coupling. The upper half of the seating has the thread cleared away except at the two top central areas directly opposite the two lower portions. When the two halves of the seating are pressed together with the screw spindle between them, the four lower portions of the female thread in contact constrain the spindle with a pressure which may be varied within wide limits. Screws formed in this way have practically no clearance and suffer from practically no backlash.[2]

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It must now be abundantly clear that the outstanding advantages of kinematic design are that:—

(1) It reduces elastic strains in the coupled links to a minimum.

(2) It eliminates many of the troublesome and costly limits on functional surfaces which would otherwise be necessary, and substitutes guiding surfaces of precision in relation to form, but not in relation to size.

(3) Adjustments are readily provided, both for functional operation and wear.

(4) Localisation of the forces facilitates design for exacting conditions of equilibrium.

The only serious objection to kinematic design is that, if rigidly applied, the load at any constraint, taking the form of a spherical surface in contact with a plane, cannot be permitted to take too high a value. Surprisingly high values of the load do not, however, appear to damage the surfaces if they are sufficiently hard and polished. In an appended note[3] a *résumé* of Hertz's theory of localised contact between deformable bodies has been sketched, and it is there seen how the safe load depends upon the elastic constants of the materials used as well as upon the maximum stress p at the centre of the area of elastic contact. The magnitude of p may safely reach values far in excess of the limit of proportionality, but at present we are ignorant of these values for the various materials of construction. This stress falls off rapidly as the boundaries of the pressure area are approached, as well as towards the interior of the solids in contact. It is therefore confined more or less to the skin of the solids making contact, and in order that the safe loading may be increased, possibly the most effective method of hardening steel constraints is by nitriding or by Edward G. Herbert's "Cloudburst" method. There can be no doubt that hardness as measured by Brinell's method is the kind of hardness which greatly influences the safe loading, so that although steel balls suitably fixed to a component form ideal points of contact, the safe loading may be increased by forming the contacts on small accessory parts, such as plugs, force-fitted to the components, and constructed of such hard materials as the cutting alloys "Ardoloy," "Cutanit," or "Wimet." As science progresses with further refinements in measurement, it is conceivable that instruments of the highest precision in the future will have the kinematic constraints constructed of such highly polished hard materials and even of sapphire or diamond.

An objection to the use of steel constraints is that relative movement in the absence of moisture causes corrosion and deposition of rust. This remarkable phenomenon, which takes place even when one of the contacts is sapphire, has been described by Tomlinson.[4] Such deposition of rust seriously interfered with the running of the ingenious friction variable-speed mechanism of Kennok Gears until it was discovered that the difficulty could be entirely overcome by lubricating the ball contacts with oil mixed with 50 per cent. of zinc oxide.[5] A film of metallic zinc of molecular thickness forms on the steel surfaces and not only prevents the corrosion, but is too thin to interfere with the manufacturing limits.

The advantages of kinematic design weigh heavily in favour of its consideration in relation to heavy-duty mechanisms and structures such as the clamps used in tubular steel scaffolding. Since the constraints are definitely located, the system of forces acting on the coupling can be calculated and the "point contacts" can be expanded into functional surfaces sufficiently extended to take the loads safely. Such procedure, however, violates the principle and careful fitting becomes necessary at the constraints, but the advantage gained in these cases is that no more constraints are designed than are necessary. The forces are definitely localised, and unnecessary strains are minimised.

Lubricated surfaces moving with relatively high velocities present an entirely different problem. The oil in such couplings is the source of hydro-dynamical pressures set up by the motion, and the present designs cannot be interfered with. They may, however, be improved in many cases as instanced by Professor J. E. Sweet, in his fascinating little book[6] entitled "Things That are Usually Wrong."

THE Southern Railway Company's station at Tonbridge is to be enlarged and improved at a cost of £95,000. The junction between the Redhill and Sevenoaks lines is to be rearranged so as to increase the speed limit of 30 m.p.h. to 40 m.p.h.

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[2] The lecturer then proceeded to consider couplings with two, three, four, and five degrees of freedom and compound couplings.—ED. THE E.

[3] Not reproduced here.—ED. THE E.

[4] "Proc.," Roy. Soc., Series A., 1927, Vol. 115, p. 472.

[5] THE ENGINEER, 1929, Vol. 148, p. 337.

[6] Published by Hill Publishing Company, New York, 1906.

The Institution of Civil Engineers.

At the opening meeting of the session on November 7th, 1933, the President, Sir Henry Percy Maybury, delivered an address to the members, of which the following is an abstract.

After expressing his appreciation of the honour which the members of the Institution had conferred upon him, the President said he proposed to take for the subject of his address phases and aspects of engineering associated with local and central government administration, in which the greater part of his life had been spent.

Upwards of forty years ago he received his first chief appointment in the local government service, and in 1913 he entered the Government service, from which he retired in 1928. He was sure it would be conceded that he had thus lived through a period of unparalleled improvement and vast changes in local and central government administration.

Prior to the date of his first appointment, county and local engineers and surveyors were often part-time officers only, but after the constitution of County Councils, and Rural and Urban District Councils, full-time officers were appointed to supervise all engineering services connected with public health, and often those of gas, water, public lighting, and highways.

After referring to the passing of the Locomotives on Highways Act, 1896, which, by permitting a speed of 12 miles an hour upon the highways, gave great impetus to the construction of the motor car, the President drew attention to the great strain which such vehicles placed upon the roads, which had never been designed or constructed to support such traffic, and which had received little or no attention since the commencement of the railway era, local authorities being seriously embarrassed by the necessity for considerable extra expenditure upon maintenance.

The motor car was becoming increasingly popular, and as a result of insistent demands, the Motor Car Act, 1903, was passed, which allowed increased speed and greater freedom to the motor vehicle, but gave no relief to highway authorities and their officers.

Eventually, in 1909, a horse-power tax was imposed upon pleasure motor vehicles and a duty upon petrol. Under the Development and Road Improvement Funds Act, 1909, the Road Board was established, primarily to receive the moneys derived from this taxation, and to allocate them to local authorities for road improvement works. It soon became obvious, however, that direct State assistance could not be confined to improvement works alone, and, in 1913, a scheme providing for the payment of grants towards the maintenance of certain classified roads was recommended by a Departmental Committee. The work of classifying the roads was put in hand, and was well advanced when war broke out in 1914.

After describing the road work carried out in France by an organisation composed principally of men drawn from the road service in this country, the President referred to the great arrears of maintenance which at the cessation of hostilities had accumulated in connection with all means of transport at home, and to the establishment in 1919 of a Ministry of Transport, under whose control all forms of transport were brought. The President was appointed Director-General of Roads in that Ministry, and held that position until his retirement from the service nine years later.

The classification of roads scheme was resumed and completed, and in 1920 the passing of the Roads Act made it possible for contributions from the Exchequer to be made to local authorities towards the cost of the maintenance and minor improvement of the roads so classified, further sums being made available for necessary road and bridge construction and for major improvements. Under the provisions of the Local Government Act, 1929, the original scheme was revised, but contributions were still made to local authorities in respect of the 42,995 miles of classified roads, representing 24·3 per cent. of the total road mileage of the country. The President then explained the organisation set up for dealing with roads under the Ministry of Transport, and referred to the power of the Minister to pay half the salary and establishment expenses of the Engineer and Surveyor in charge of highways.

After giving particulars of the road works which, soon after demobilisation, were put in hand in and around London to relieve unemployment, he referred to the many road and bridge works which had been carried out all over the country since the war, and, in connection with the construction of the Mersey Tunnel, said he was sure that all members present would desire to express their sympathy with Sir Basil Mott (whose name would always be associated with that great work), and to wish him a speedy recovery.

The President then referred to the debt of gratitude which the nation owed to the civil engineering profession for splendid services in carrying out the vast programme of new roads, and said it was unfortunate that such great engineering works should be the subject of controversy. The works described, however, were instrumental in providing a large amount of employment, during a difficult industrial period, and much of what had been done was bound to prove of inestimable value to the community as a whole. The great improvement of roads during post-war years would be reflected in reduced costs hereafter.

He expressed the opinion that engineers employed on highways need not be apprehensive that their duties would suffer diminution, and referred to the necessity for devising means for reducing the alarming number of accidents on the highways of the country. That problem should receive quite specialised attention, and he suggested that chief engineers should seriously consider the advisability of including in their organisations traffic branches, whose sole function should be the study of this grave problem. He also referred to the work of the Traffic Signs Committee, which reported in May last, but feared that when everything humanly possible had been done, there would always be a large number of inefficient and careless drivers, whose incapacity and want of thought would endanger the lives of others.

In connection with the development of the love of travel in post-war years, he said that whilst each person in Greater London travelled on an average 283 times on one or other of the rail and road services in 1912, in 1932 the number of journeys per person had risen to 482, and it was only to be expected that this love of movement would continue.

He drew attention to the development of air transport, to the grouping of the railways under the provisions of the Railways Act, 1921, to the great work carried out by the Electricity Commission and the Central Electricity Board, and referred to the great problem of London traffic, and the establishment of the London Passenger Transport Board under the provisions of the London Passenger Transport Act of the present year.

Travel over the highways having long since lost all local colour, the President wondered how long it would be before the control and management of the highways outside big centres of population would be entrusted to some public board or authority.

He referred to the necessity for taking a wide view in dealing with transportation matters, and for providing for the adequate lay-out of highways on sound transport lines in all regional town planning schemes.

In dealing with local government he had, not unnaturally, given prominence to engineering related to highways and bridges, and the traffic thereon, but he had by no means forgotten the other great and important engineering works entrusted to local authorities, many of which he enumerated.

He stated that there were on the roll of the Institution nearly 11,000 members resident in all parts of the world, and drew attention to the increasing number of municipal and county engineers in that membership.

The outlook for civil engineers (he continued) is somewhat depressing, and it is a source of grief to the older members that so many of the younger professional men should be out of employment; but there is clearly an improvement manifesting itself. Our basic industries have at last made a move forward, resulting in increased employment for our workpeople, whilst the traffics recorded weekly on our transport services show gratifying increases. The figures which have been made available to us in the national revenue returns are also very encouraging, and although it may take some time to reach the end of the depression, be sure the tide is coming in.

A hundred years ago, under not dissimilar world conditions, that great essayist, Lord Macaulay, wrote :—" History is full of the signs of the natural progress of society. We see in almost every part of the annals of mankind how the industry of individuals, struggling up against wars, taxes, famines, conflagrations, mischievous prohibitions and more mischievous protections, creates faster than governments can squander, and repairs whatever invaders can destroy. . . . The present moment is one of great distress. But how small will that distress appear when we think over the history of the last forty years —a war, compared with which all other wars sink into insignificance—taxation, such as the most heavily taxed people of former times could not have conceived; a debt larger than all the public debts that ever existed in the world added together; the food of the people studiously rendered dear; the currency imprudently debased, and imprudently restored. Yet is the country poorer than in 1790? We firmly believe that, in spite of all the misgovernment of her rulers she has been almost constantly becoming richer and richer. Now and then there has been a stoppage, now and then a short retrogression; but as to the general tendency there can be no doubt. A single breaker may recede; but the tide is evidently coming in. . . . On what principle is it, that when we see nothing but improvement behind us, we are to expect nothing but deterioration before us?"

That history will repeat itself, and that, once again, members of the civil engineering profession will be fully employed I have little doubt. There are, however, a few home truths which I would like to submit before closing my address. I would like to ask this question: How many of our younger members are fitting themselves for the great responsibilities to which they should eventually succeed? I was reading the other day that most charming and instructive address which was given to this Institution by our great and revered leader, Sir Benjamin Baker, in 1895. Dealing with the education of engineers at that time, he said :—" If anything more remains to be said on the subject, it must therefore be of the nature of a warning, that technical education is of little value unless accompanied by the practical experience, sound judgment, and bold initiative which, rather than book knowledge, characterised the famous members of this Institution in the past. Education will do much, but it will not endow a man with common sense, nor will it make his opinion on a multitude of important subjects worth more than that of a naturally observant person." Later, Sir Benjamin said :—" . . . blind acceptance of authoritative statements in books, without due regard to the sufficiency of the data upon which those statements were founded, obviously warped their judgment. There are not wanting contractors and manufacturers who contend that some of the highly trained young engineers of the present day are not wholly free from faults of the latter kind. It may be well, therefore, for all engineers to remember that most of their elaborate calculations involve some assumption which is more convenient than true."

Those words, delivered from this chair thirty-eight years ago, are very largely applicable to present-day conditions, and I would commend to all, old and young, the very sound advice which was tendered by one who was not only eminent in his profession, but a great leader of men.

SIXTY YEARS AGO.

Of the two leading articles in our issue of November 14th, 1873, one was devoted to the fate which had overtaken Inigo Jones' water gate at the foot of Buckingham-street, near Charing Cross. The other, by way of contrast, discussed railway construction in Ashantee. The construction of the Thames Embankment had left the water gate, the last remaining vestige of old York House, far inland from the margin of the river. It stood, and still stands to-day, on the Strand side of the gardens which the Metropolitan Board of Works—the forerunner of the London County Council—laid out on the reclaimed land between the old and the new river line. We were grieved at the fact that the level of the garden ground was higher than that of the water gate, and that it had been found necessary to raise the ground round the old structure, until it appeared to be sinking like a stage ghost through a trap door. Some question of divided ownership apparently prevented the Board from dismantling the structure and re-erecting it on a higher level. To-day the old gate, an object of much interest to London visitors, still stands in the pit created for it when the Embankment Gardens were planned. . . . With railways in Ashantee we were concerned because of the approaching campaign under Sir Garnet Wolsely, for which the final preparations were then being made. On a previous occasion we had criticised the choice of artillery material which Sir Garnet had made for the expedition. Now we took exception to his plan, under which 10,000 tons of railway material were to be shipped to Africa to facilitate the progress of our forces from Cape Coast Castle to Coomassie. We maintained that the country was not suitable for the construction of a railway, and that if one were built it would cost more lives to defend than it would save. Appealing to history, we turned back to the times of Napier and Havelock, even to those of Wellington, and showed that in India and in the Peninsula they had relied on the primitive means of transport provided by the country rather than upon more highly developed systems which they might have imported. We were not blind to the use which the Germans had made of the railways in the Franco-Prussian War, nor to the inestimable services which the railway constructed by us in the Crimea had rendered. But in Ashantee, so we argued, the latest developments of mechanical science would be out of place and might well prove an embarrassing over-refinement which would seriously affect the success of the campaign. That fate, before now, had, we urged, befallen more than one highly disciplined force in the face of a savage or inferior foe. The history of the campaign, as we now know it, seems to justify our criticism of the mechanical equipment prepared for it.

The annual census of motor traffic taken by the Automobile Association at more than 100 spots in England, Wales, and Scotland, during a week in September, shows that there was an increase of 42 per cent. as compared with 1932. Private cars increased by 19 per cent., heavy motors by 12 per cent., and motor cycles by 12 per cent. As compared with the corresponding week of 1928, the increases were 49 per cent. for private cars and 63 per cent. for heavy motors. There was a decrease of 8 per cent. in motor cycles. The census of this year included 3,252,050 vehicles.

A new photo flash lamp that gives more light for its size than any source in existence to-day, and designed especially for amateur use, where it is expected to open new picture-taking possibilities, has been developed by the Incandescent Lamp Department of General Electric Company, of New York, at Nela Park, Cleveland. The bulb of the new lamp contains a quantity of extremely fine aluminium foil crumpled around a 1·5-volt filament. The remainder of the bulb interior is filled with pure oxygen, and it is the rapid oxidation of the foil which causes the tremendous light output. One lamp is usually sufficient for photographing subjects up to a distance of 12ft. with any type of camera when fast amateur film is used. The noiseless, smokeless flash emitted occupies one-fiftieth of a second.

Railway and Road Matters.

The report by Lieut.-Colonel Mount on the fatal collision of July 10th at Little Salkeld was issued on November 3rd. A summary is printed on another page of this issue.

Modernisation schemes which include the provision of large mechanical coaling plants are to be carried out by the L.M.S. Railway Company at the locomotive running depôts at Ashton (Birmingham) and Rugby.

The L.M.S. Railway Company has decided to exhibit the full name of Llanfair Station. It is Llanfairpwllgwyngyllgogercychwyrndroblllllandysiliogogogoch, and signifies "the Church of St. Mary in a hollow of white hazel near to a rapid whirlpool and to St. Tysilio's Church, near to a red cave."

There is now under construction in Germany a 4-4-4 oil locomotive of 1000 B.H.P., which is fitted with direct drive—only the third example of this principle in twenty years. It is powered by a four-stroke engine, and will thus be somewhat more flexible than the previous direct-drive locomotives, which had two-stroke engines.

The new station of the L.M.S. at Leigh-on-Sea, with a large goods yard adjacent, is situated a short distance to the west of the present station, which is inadequate for the growing traffic and will be closed as soon as the new one is opened on January 1st. Another new station at Chalkwell, on the Southend side of Leigh-on-Sea, was recently opened, thus providing the district with two stations instead of one.

The Ministry of Transport railway statistics for July show that, when compared with the corresponding month of 1932, there was an increase of 2·8 per cent. in the number of passenger journeys, but a decrease of 7·0 per cent. in the receipts from passengers. The tonnage of freight carried increased by 2·0 per cent., and the freight traffic receipts by 1·4 per cent. Freight train-miles rose by 1·8 per cent.; the average train load from 114¼ tons to 116; and the net ton-miles per engine-hour from 430¼ to 439¼.

The opening of the new service between Cockfosters and Uxbridge has led to the London correspondent of a North-country paper giving a few interesting items on the electrification of the Underground. Therein it was observed that steam-worked goods trains can still occasionally be seen on their way to Smithfield Market. Those, we would remark, are those of the Great Western Company. Additionally, there may be added the Midland—now the L.M.S.—coal trains from the North and South-Western Junction Railway at Acton, through Hammersmith and Earls' Court to West Kensington and back.

Work has been started in Germany on the construction of three Transcontinental motor roads in combination with the railway system which, like the Italian motor roads, will be reserved for motor traffic only. They will total 6500 kiloms. in length. The tonnage of constructional steel required will amount to over 200,000 tons, and the building of the roads is to extend over twelve years. The Government is to guarantee the interest on the money spent, but the scheme will receive the financial support of the banks, the motor industry, the steel and heavy machine industries, and foreign capitalists. One of the most important roads will be that from Lübeck-Hamburg to Frankfort and Basle, in Switzerland.

A very interesting railway case was recently before the Court of Appeal, which implies that the farmer must share with the dairy companies and the railway companies the economies that result from the bulk conveyance of milk. The contract between the farmer and the dairy company provided that the former was to be paid a specified amount "less a sum equal to the railway carriage of the milk to London." As a result of the milk being conveyed in 3000-gallon tank wagons, the railway gave the dairy company a rebate of 30 per cent., and the judgment of the lower court, now confirmed by the Court of Appeal, was that the defendants were not entitled to deduct a sum in excess of that actually paid.

In view of the retirement on December 31st next of Mr. A. C. Stamer, assistant chief mechanical engineer, London and North-Eastern Railway, there are to be a southern area and a north-eastern area mechanical engineer. Mr. R. A. Thom, now mechanical engineer, Doncaster, takes the former position, and Mr. E. Thompson, mechanical engineer, Stratford, takes the north-eastern area. Mr. A. H. Peppercorn, carriage and wagon works manager, York, becomes assistant mechanical engineer, Stratford; Mr. W. H. Brown, carriage and wagon works manager, Doncaster, succeeds Mr. Peppercorn; and Mr. D. R. Edge, carriage and wagon works manager, Dukinfield, goes to Doncaster to follow Mr. Brown.

At a luncheon at Olympia on November 2nd, in connection with the Commercial Motor Transport Exhibition, Mr. Oliver Stanley, the Minister of Transport, spoke of his hopes of the Traffic Advisory Council, which is to be set up under the Road and Rail Traffic Bill. He said that it would be "a tremendous advantage if they could get some system that would give a fair chance to all the varying forms of transport. If, as a result of the Traffic Advisory Council, they could come to some arrangement with all the branches of the transport industry, it would be to the advantage not only of the country, but of the industry itself. It would be worth their while to make this Council a live body, and that depended on the people whom they put on it and the support they gave them."

The announcement made herein on August 11th as to a co-ordination between the four grouped companies and the cartage firms of Carter, Paterson and Co. and Pickfords, may now be followed by the intimation that the railways have purchased, as from October 31st, in equal proportions, the whole of the ordinary capital in the cartage companies, and the boards of the latter have been re-arranged to suit. As we have seen this described as a purchase of rival interests, we would say that that is hardly so, except in the London area; most of the traffic collected by the cartage firms eventually found its way on to the railway. A direction to which we would like to see the railway companies turn their attention is the hundreds of thousands of pounds they pay out yearly in what is termed in the Railway Returns as Passenger Ticket Agents' Commission. That amount last year was £240,340, but in such a normal year as 1928 it was £325,408.

Notes and Memoranda.

It is only within the last few years, says a report on the Influence of Temperature upon the Strength Development of Concrete, recently issued by the D.S.I.R. (Building Research), that it has been realised that the expansion due to heat hydration of the cement, followed by contraction on subsequent cooling, has been largely responsible for the detrimental cracks that have been observed in large concrete masses.

It is reported that Professor Swaardemaker has constructed an absolutely non-resonant studio in Utrecht. Between each of the walls a complete vacuum has been achieved. Each wall has a composition of paper, wood, cork, seaweed, human hair, and a special sort of stone, and the internal wall is hung with a "variety of tissues." It is not stated whether the studio is intended for broadcasting or as a refuge from it.

Writing in *Cheap Steam*, the house journal of Ed. Bennis and Co., Mr. E. Ingham says that experience shows that when a change is made from oil-firing back to coal firing, there is a certain amount of risk of flue explosions when the boilers are started up again. If the oil-firing has not been efficient, partially consumed oil may have settled on the inside surfaces of the flues, and given off vapour, which, mixing with air in the right proportions, will form an explosive mixture. When the boilers are started up, sparks from the furnaces may then ignite the mixture. It will be realised that to enter the flues of an idle oil-fired boiler with a naked light is a somewhat risky proceeding; the flues should always be ventilated first.

The national grid, the problem of distribution, and the development of sales formed the subject of Mr. G. G. L. Preece's inaugural address as Chairman of the North-Western Centre of the Institution of Electrical Engineers on October 24th at Manchester. The "grid," he said, was based on estimates of consumption that proved to be unduly optimistic, but who could have foreseen the great trade depression? The Central Electricity Board was undoubtedly anxious and recognised that great efforts must be made to ensure the grid being a financial as well as a technical success. Hence the reorganisation of the E.D.A. and the proposed reorganisation of distribution. The one guiding principle should be trusteeship, and the time was not far distant when the running of electricity undertakings for any other purpose than the benefit of the consumers would not be tolerated. National public control would come eventually, if not immediately.

In addition to their use for high-speed cutting, the tungsten-carbide alloys find numerous applications where their resistance to wear is of value. Thus, in one plant having a large number of hydraulic presses, ranging in capacity from 25 to 2000 tons, four men, says *Machinery*, were formerly kept busy replacing worn stems and seats. Since this concern adopted the practice of tipping the stems and seats with tungsten carbide, the part-time service of one man only is required for this work. The work blades of centreless grinders are subject to such severe wear in many operations that frequent redressing is necessary. In order to reduce maintenance costs in a gear-manufacturing plant it was decided to provide the work blades of the centreless grinding machines with tungsten-carbide inserts. As a result, 10,000 pieces per grind of the blades are now obtained regularly, as compared with 1600 pieces formerly. In one instance 574,000 pieces were obtained per grind of the tungsten-carbide blades, as compared with less than 2000 with blades made from other materials.

The High Pressure Committee of the Department of Scientific and Industrial Research has, according to Professor G. T. Morgan, sanctioned the use of much higher pressures for autoclave work and has approved of Mr. Tongue's design of plant sufficiently strong to withstand a pressure of 3000 atmospheres. This apparatus, which has now been constructed entirely in the laboratory workshop, has been employed in a few preliminary experiments. This super-pressure plant consists essentially of a screw compression pump and an autoclave. It is housed within a steel enclosure, and all the controls are operated from outside. The pump, which has a capacity of 30 c.c. and a plunger diameter of 12·7 mm., is capable of raising the pressure of liquids or gases to the desired extent—*i.e.*, 3000 atmospheres. The cylindrical autoclave is 20·5in. long, with a ⅞in. bore; it has an outside diameter of 11in. and its capacity is 110 c.c. Heating, effected by means of an oil tank, raises the temperature to about 140 deg. Cent. The forgings for the apparatus were made by Hadfields, of Sheffield, and all the pressure-resisting parts are made of nickel-chromium-molybdenum heat-treated steel.

Glowing filaments of broken electric lamp bulbs are capable of igniting fire-damp, and in a paper entitled "The Ignition of Fire-damp by the Filaments of Broken Electric Lamp Bulbs," by G. Allsop and T. S. E. Thomas, of the Safety in Mines Research Board, an account is given of experiments which have been made to determine the limits of the efficacy of the current-interrupting devices sometimes used with a view to preventing such ignition. The assumption upon which these devices are designed is that no danger of ignition of fire-damp can exist so long as the filament, if accidentally exposed, does not continue to carry a current. In fact, however, although the temperature of the filament begins to fall immediately the current is interrupted, the filament does not cool instantaneously because of the heat stored in its mass, and for an appreciable time it may remain incandescent at a temperature above the minimum temperature necessary for the ignition of fire-damp. The rate of cooling of the filament of a lamp bulb is, therefore, one of the principal factors which determine whether the filament can ignite fire-damp, and details are given of the cooling rate of filaments and of the relationship between the rating of a bulb and the time of cooling of its filament. The results of the experiments indicate that no current-interrupting device, unless it can cut off the current before the glass of the bulb is broken, can be effective for any lamps the filament current of which exceeds about 2 ampères. With smaller currents at voltages up to 6, the device may be successful, particularly with gas-filled bulbs. The paper may be obtained from H.M. Stationary Office, price 6d.

Miscellanea.

The new mines rescue station for Lancashire and Cheshire, at Boothstown, is to be formally opened on Saturday, the 11th inst.

The British Columbia Electric Railway Company, of Vancouver, proposes to construct a power plant of 4600 horse-power in the town of Bridge River. The cost is estimated at 300,000 dollars.

The construction of a coal carbonisation and natural gas plant in Regina, Alberta, at a cost ranging from 250,000 dollars to 400,000 dollars, is contemplated by a company launched by Edmonton business men.

A Swedish firm has, according to *Indian Engineering*, secured the contract for the construction of a railway across Persia from the Caspian Sea to the Gulf of Basra. The new line will be about 1000 miles long, and will take five years to build.

It is said that the paper-making machine which is being made by Walmsleys (Bury), Ltd., for the Kemsley mill of Edward Lloyd, Ltd., will be the largest in the world. It is to have a width of 320in., and will have an output of 1000 tons of newsprint a week.

A sodium sulphate refining plant is to be put up at Inglebright Lake, 40 miles north of Maple Creek, Saskatchewan, by Metallics and Non-Metallics, of Toronto. The initial expenditure is to be 150,000 dollars, but the plant will probably be extended at a cost of 1,000,000 dollars.

It is expected that coal drawing at the Cowpen Company's new pit at Blyth, which is close to the loading staiths, will be commenced early in December. At the outset a yield of about 500 tons per day is expected. It will be a progressively increasing addition to the trade of the port.

The Lords Commissioners of the Treasury have approved a scheme submitted to them by the Import Duties Advisory Committee for the allowance of a drawback at the rate of 6s. 2d. a ton in respect of the duty paid on solid coal tar pitch used in the manufacture of coal briquettes.

It is reported that the firm of Siemens-Schuckert, of Berlin, has, through its subsidiary, Siemens-Schuckert (Ireland), been awarded the major portion of the contract for the erection and equipment of the three new sugar beet factories at Thurles, Tuam and Mallow. The value of the contract is stated to be about £1,500,000.

During the tunnelling operations for the condensing water for the King's Dock power station, Swansea, an accident occurred on the 4th inst. One man was killed and six others injured by an explosion, the cause of which has not yet been determined. The tunnels are about a mile long and have passed through several coal seams.

The effect of the tariff on steel was shown at the meeting of the Tees Conservancy at Middlesbrough on the 6th inst., when it was stated that during the twelve months ending October 31st only 14,664 tons of steel were imported, against 126,759 tons in the corresponding period last year. The iron and steel works on the North-East Coast are busier than they have been for several years.

A fuel research survey paper dealing with an investigation into the accuracy of routine analytical determinations on coal and coke has been published by the Department of Scientific and Industrial Research. Most of the results were obtained from investigations carried out jointly at Newcastle by the staff of the Department's coal survey laboratory and the staff of the Northern Coke Research Committee.

Work is to be started immediately on the new £527,000 bridge over the Forth at Kincardine. The erection of the bridge is anticipated to take two years. The bridge is to be half a mile in length, with twelve 50ft. spans and two central spans of 150ft., which will be pivoted to permit the passage of shipping. The bridge roadway will be 30ft. above high-water level. The steelwork is to be supplied by the Cleveland Bridge and Engineering Company.

In the course of his Andrew Laing Lecture, before the North-East Coast Institution of Engineers and Shipbuilders, in Newcastle, Professor F. C. Lea said that much had already been done by well-directed research by metallurgists to meet the pressing needs of the mechanical and structural engineer. It remained with engineers to make the best use possible of the materials available, to investigate fully their properties, and to use them with knowledge and courage when, by doing so, greater efficiency and real progress could be attained.

A new hydro-electric power station has recently been completed at Alloz by the Sociedad Fuerzas Electricas de Navarra, of Pamplona. The station is situated at the foot of a dam on the river Salada in the province of Navarra. The water stored in the reservoir formed by the dam is used only during the summer periods, primarily for irrigation purposes, and partly for power generation. The plant, which works under a head varying between 105ft. and 210ft., comprises two 6000 horse-power Francis-type turbines, coupled direct to Oerlikon 4200 kVA, 5000-V A.C. generators (375 r.p.m.). The power is stepped-up for transmission purposes to 60,000 V by two Oerlikon transformers.

Speaking at an informal meeting of the Institution of Electrical Engineers, held on October 30th, the new President, Mr. P. V. Hunter, said the case for underground cable transmission in rural areas had not received adequate consideration, and except for the opinions expressed by Dr. Ekstrom a year or two ago, the overhead transmission line had hardly been challenged. Too often comparisons of cost were made of areas and conditions very different in soil and climate, but Holland, with 11,000-volt transmission, almost entirely underground, and Switzerland with overhead lines, both found supply to rural areas a paying proposition. The Dutch system used cables of two sizes, but he believed Dutch engineers had found the larger more practical, and he suggested for rural England the adoption of a standard three-phase cable, 0·05 square in., 11 kV lead-covered, taped and compounded, thereby eliminating all variation of size and shape, and allowing for very ample supply.

THE VITRY-SUR-SEINE LOCOMOTIVE TESTING STATION

(For description see page 465.)

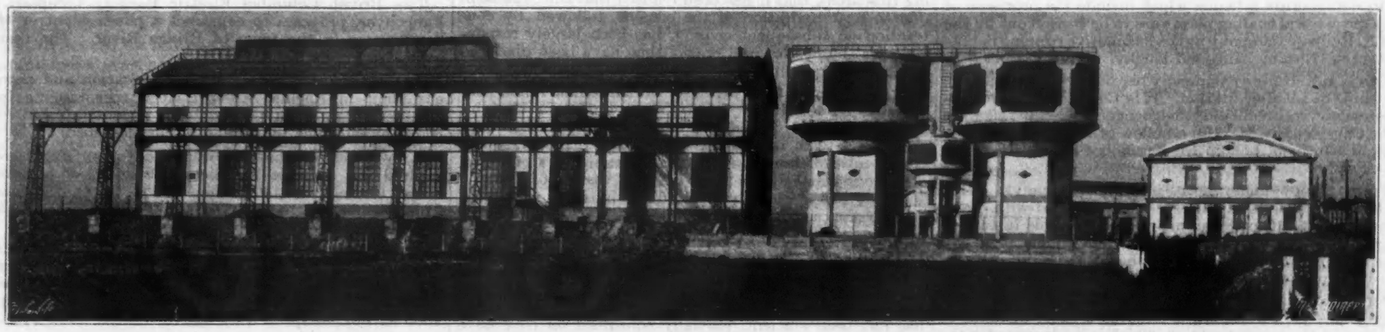

FIG. 1—EXTERNAL VIEW OF BUILDING SHOWING COAL YARD AND WATER TOWERS

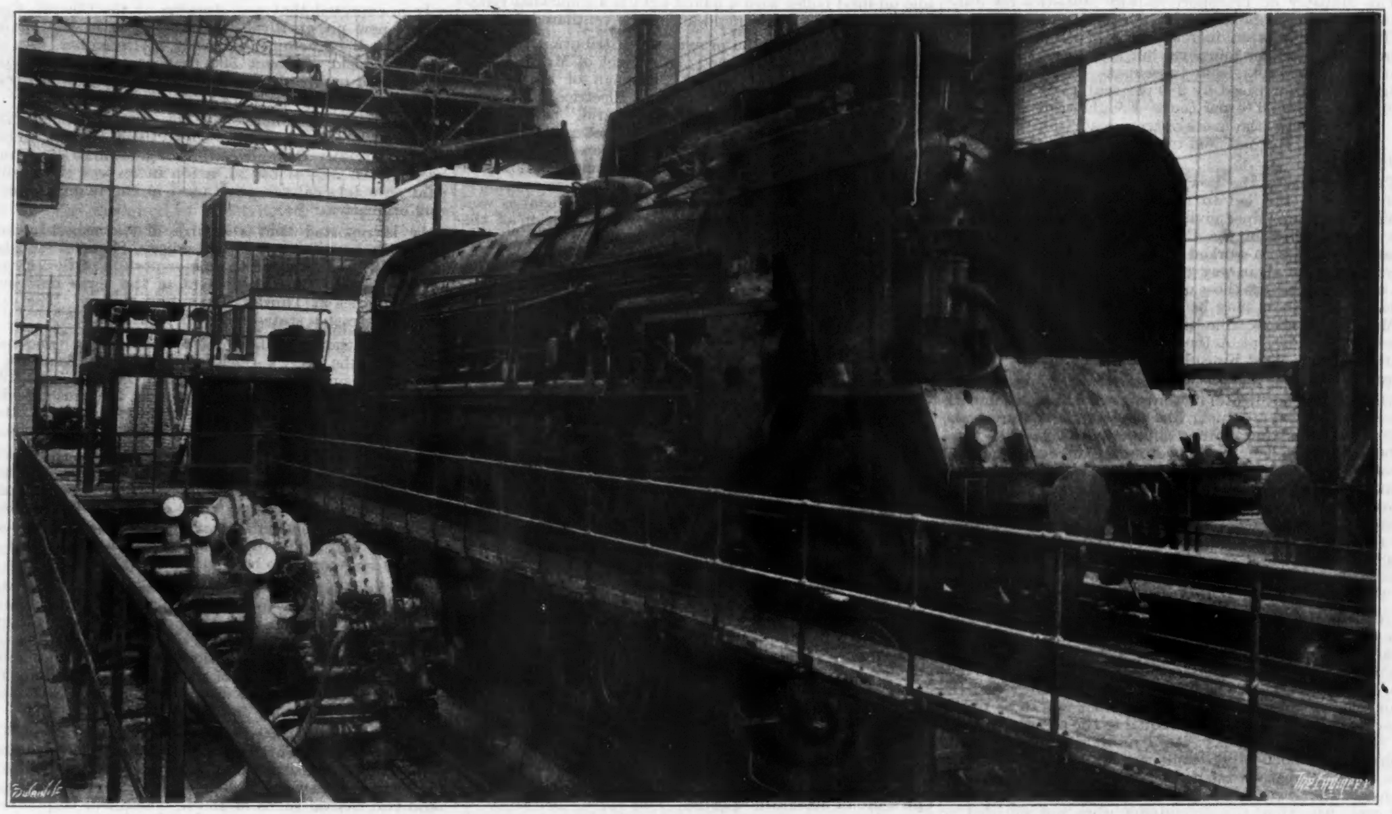

FIG. 2—P. L. M. 2-8-4 LOCOMOTIVE UNDER TEST

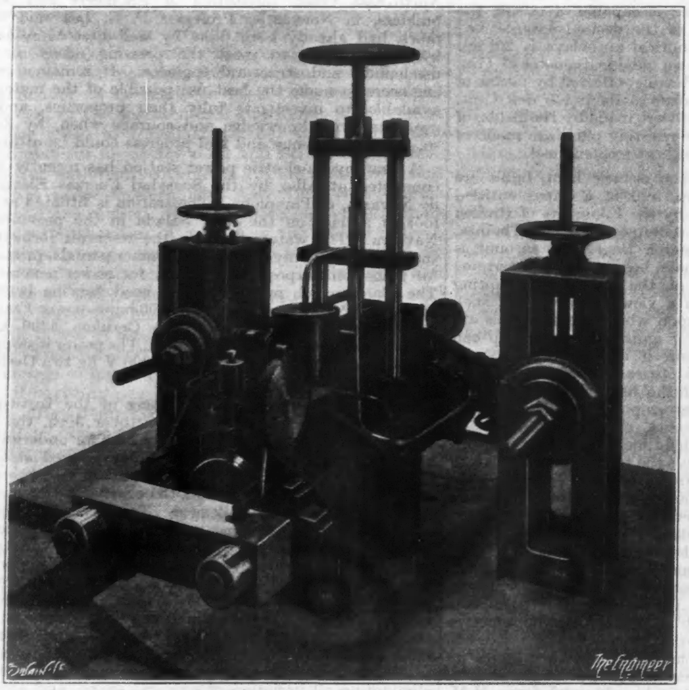

FIG. 3—AMSLER HYDRAULIC DRAW-BAR DYNAMOMETER

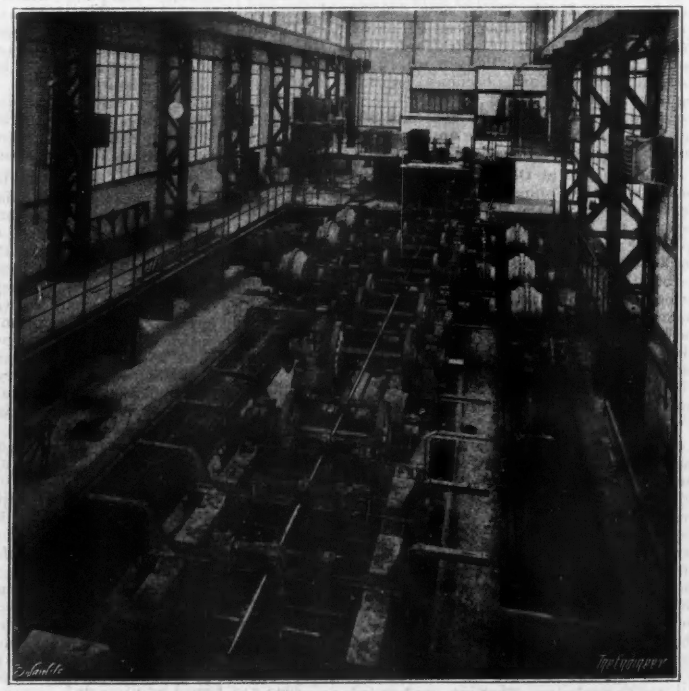

FIG. 4—GENERAL VIEW OF THE TEST PIT

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KINEMATICAL DESIGN.

The general study of the motion of bodies is divisible into two parts. Kinematics, the geometry of motion, is concerned with the displacement, velocity, and acceleration of bodies. Under kinetics, or dynamics, we study the causes of motion—that is to say, the forces and resistances in action restraining a body to a specified path, and giving it its specified velocity and acceleration along that path. Briefly, kinematics deals with the movement of bodies, and kinetics with the cause of that movement. This division of the study of motion into two parts is familiar to all readers of physical text-books. For the most part, however, the division is largely of academic interest, and in practical work is speedily forgotten. Every physical problem has its kinematic and its kinetic aspect, but the conscious recognition of that fact does not materially assist us to arrive at a solution. The geometrical motion of a body, the kinematic aspect, may be specified, and from it we may be required to deduce the forces which must be in action, the kinetic aspect. Conversely, we may know the forces in action, and the problem may be to deduce therefrom the geometrical motion which will result. Kinetics is founded on Newton's laws of motion, and of universal gravitation, upon Hooke's law of elasticity, upon Boyle's and Charles' laws and upon other formalised expressions concerning the effect of force on matter. Kinematics is a branch of geometry, and excludes force and mass from its consideration. A study of the displacement, velocity, and acceleration of the piston of a reciprocating engine presents purely kinematical problems. When we pass on to investigate the stresses in the piston-rod and the connecting-rod, the reaction on the crank pin, and so forth, we enter the field of kinetics. This distinction between kinematics and kinetics may appear to be, and, in many respects, undoubtedly is, something of a refinement. It is, however, necessary to understand it if we would gather the full implications of Professor Pollard's lecture delivered last Friday before the Institution of Mechanical Engineers. His subject was "Kinematic Design in Engineering." It was a fascinating subject, ably presented, and the audience which the lecture attracted displayed marked absorption in it. The lecture had but one fault. It failed almost completely to fulfil the promise of its title. Very nearly the whole of it was devoted to a discussion of kinematic design in instrument-making. Scarcely anything was said concerning kinematic design in what, in contrast with instrument-making, and following Professor Pollard's example, may be called heavy-duty engineering. The explanation is not difficult to find. Kinematic design is in general not directly applicable to heavy-duty engineering.

As Professor of Instrument Design at the Imperial College of Science and Technology, Professor Pollard had a good personal reason for confining himself in his lecture almost wholly to examples of kinematic design in the production of instruments. Beyond this personal one, however, there was a fundamental reason why the field of the lecture should be restricted in this manner. Instrument making is a branch of mechanical production in which geometrical motion, or absence of motion, is the prime consideration. In what we have called heavy-duty engineering, the production, transmission, or resistance of force is a major factor with which accuracy of geometrical motion may or may not be combined. In other words, instrument-making is primarily kinematical in its outlook; engineering, as distinct from instrument-making, is essentially kinetic. In the light of the definitions of these two conceptions, it seems to be almost a contradiction in terms to associate the word kinematic with engineering design. It can be granted that the border between instrument-making and heavy-duty engineering is very indistinctly defined. A large astronomical telescope, or an 18ft. measuring bench, such as that at the National Physical Laboratory, although instrumental in its function, is a product which comes well within the field of heavy-duty engineering in so far that its own massiveness imposes on the designer the necessity for considering questions of force and stress. Again, certain small high-precision machine tools —such as the Hilger lathe, which we described in our issue of December 17th, 1926—closely approach the category of instruments, since the great accuracy of motion which is required dominates the provisions made to enable the machine to fulfil its duty as a cutting device. A lens-grinding machine perhaps provides the most striking example of an appliance which, although its primary duty is the exertion of force, is essentially an instrument as judged from the aspect of geometrical motion. Apart, however, from this field, within which the two categories overlap, the distinction between the kinematical instrument and the kinetic machine is fundamental not only on what may be deemed academical grounds, but for reasons which are thoroughly practical. The case of a shaft mounted to rotate in ball bearings provides a good illustration. Kinematically, the shaft may be supported in two bearings, each containing three balls set at 120 deg. apart. If the bearings are in excess of two, or if the number of balls in each exceeds three, redundancy will be introduced into the support of the shaft and ambiguity will exist concerning the axis of rotation. In this connection it may be noted that the use of rollers instead of balls is kinematically equivalent to the use of more than two ball bearings. For instrumental purposes two three-ball bearings might be used to support a shaft which is to be free to rotate. If, however, the shaft has to transmit not merely motion but force, and if its own mass is sufficiently great to introduce secondary forces which are not negligible—in a word, if the shaft is part of a kinetic machine and not of an instrument—then its support on two three-ball bearings may be ruled out as impracticable. It is impracticable because of the intensity of the pressure which would be thrown upon the areas of contact between the shaft and the balls or the balls and their races, and because it fails to provide the mechanical surfaces necessary for the establishment and maintenance of hydro-dynamical lubrication. To reduce the bearing pressure, and to provide the means for hydro-dynamical lubrication, it is necessary to introduce redundant constraints; in other words, to depart from the principles of kinematic design. We have, in fact, to multiply the number of points of support until they reach the infinite number provided by a plain journal bearing. To take another illustration, let us suppose that we have to devise a table constrained to slide horizontally in a straight line. Kinematically, the constraints will be completely provided by six balls, three between the table and its bed, two between one edge of the table and the edge of the bed, and one between the edges on the opposite side. A seventh ball or bearing point introduced anywhere would be redundant, and would create the possibility of a small degree of freedom additional to that which alone is desired. For instrumental purposes, a six-ball supporting system would be satisfactory, since geometrical motion and not force and mass is the prime consideration. If, however, the table is the table of a planing machine, the six-point system of support becomes impracticable, because, with the introduction of forces and masses as prime factors in the problem, we are compelled, as before, to consider bearing pressures and lubrication. In addition, in this case, the practical possibility of the sagging of the table, under its own weight and the load upon it, is a factor militating against the adoption of the kinematically ideal system of support.

The general principles of kinematic design are not new. They were taught and practised to a considerable extent by Lord Kelvin, who, apart from being a great natural philosopher, was, significantly, an instrument maker rather than an engineer. Professor Pollard has done a very great deal to systematise the principles of kinematic design, and to secure its adoption among instrument makers. Although he maintains that "the advantages of kinematic design weigh heavily in favour of its consideration in relation to heavy-duty mechanisms and structures," it is, we think, symptomatic that in the whole course of his printed address he mentions only two instances in which the principles of kinematic design have been applied to engineering outside the field of instrument making, the three-point system of supporting motor car engines and clamps for tubular steel scaffolding. We would not, however, have it thought that, in our opinion, the lecture, addressed as it was to a body of engineers rather than of instrument makers, was without practical importance. On the contrary, we are convinced that it will, or can be made to, serve a most useful end. Engineering, it may be definitely asserted, depends for its progress in a most intimate manner upon the instrument maker and the instrument user. It is sufficient in this connection to recall the vital services rendered during the war by the National Physical Laboratory to the engineering industry, struggling to adapt itself to the new and in many cases exacting conditions which it was called upon in the country's interests to face. The engineer, if he is not an instrument user himself, depends upon the services of those who are. Many engineers are users of instruments, and not a few are called upon at times to make and occasionally to design instruments for the use of others or for their own special needs. It is therefore desirable in these circumstances that the engineer should have a proper and full understanding of sound principles of instrument design, and in that respect there can be no doubt whatsoever that the kinematical methods expounded by Professor Pollard provide the only true guidance. Furthermore, a knowledge of the principles of kinematic design is of value to the designer of heavy-duty engineering products. He may never or rarely be able to apply them fully and unmodified in practice. A knowledge of them will, however, go far to clarify his mind when he is faced with complicated conditions, and will enable him to discriminate wisely between the merits of two or more alternative plans.

Continental Industrial Plans.

The signs of recovery in the British engineering industries are generally taken as indicating a gradual return to normal conditions, and there is no reason for supposing that manufacturers will not get back a fair share of foreign trade in the future. If they succeed in doing so it can only be by adapting themselves to circumstances which have entirely changed the conditions under which business can be transacted with some foreign markets, notably those that have developed industries and are narrowing down the possibilities of trade for manufacturers in other countries. It is curious, therefore, to observe the tendency in France, where a definite plan to revive trade by international collaboration was revealed in the message which Monsieur Sarraut read to the Chamber of Deputies last week when presenting the main lines of the new Government's programme.

Whatever may be the fate of Governments, the plan will doubtless remain. It was prepared after consultation with industrial interests, and reflects ideas that have been crystallising for a long while. Monsieur Sarraut has had an extensive experience of the Far East, and he falls in with the view that Eastern markets are being lost to European manufacturers, who, he says, are reduced to the necessity of competing amongst themselves under conditions of monetary chaos. So far as engineering products are concerned, there appears to be no reason for supposing that countries in the Far East will be able to dispense with, say, Western machinery, even though Japan should extend considerably her manufacturing equipment, and the belief entertained abroad that Russia is looking more particularly to Asiatic markets is not likely to disturb unduly British engineers. Nevertheless, Monsieur Sarraut is of the opinion that Europe is "unconscious of the perils" surrounding it, and the plan of his Government is to consolidate the industrial and commercial situation of his country and to be ready at an opportune moment to collaborate with other nations for a general economic reconstruction. Temporary measures for stimulating activity, such as the programme of national public works, are retained in the plan, the chief feature of which is the use to be made of import quotas as a means of promoting exchanges with other countries. The quotas had a disastrous effect upon the French export trade so long as they were applied indiscriminately without system, but they are now recognised as offering the only practical means, under present circumstances, of negotiating commercial agreements. They obviously imply limitations, for the more a country seeks to supply its own needs the less it is able to take in exchange for the sale of its goods and produce. Some foreign markets will presumably have to be sacrificed for the country's good. This plan is to be built up in a solid foundation of colonial development. A great deal of work has been accomplished in Africa with a view to the production of raw materials, and for a long time to come this work will continue to provide an outlet for engineering activity. The belief that France can become largely self-supporting with an African market for home manufactured products capable of almost unlimited expansion is not entertained by those who know the colonies best. A sparse population over a vast territory has little need of European goods, or the means to buy them. A colonial development on the scale contemplated by the French can only be effected by Europeans with the aid of machinery in the laying out and cultivation of plantations. All attempts to do this so far have failed financially. The native contribution is comparatively small and is limited to natural products requiring little labour. At the best, colonial development is a slow process depending upon the world prices of raw material. It is doubtful, therefore, whether, apart from North Africa, the idea of a dependence on colonial resources can influence appreciably the French policy in the way of commercial arrangements with other countries. Essentially French products must find an outlet to foreign markets, and now that the French realise their dependence upon foreign trade they are prepared, and anxious, to collaborate in any plan for a return to international trading activity on the basis of a reciprocal exchange of goods and produce.

Perhaps the most striking evolution of trade policy is that observable in Belgium, where industries are essentially exporting, and the country has therefore always pursued a liberal trade policy as necessary to its national prosperity. It has striven to maintain that policy and endeavoured to extend it by means of the Ouchy Convention, whereby the Belgium-Luxemburg Union and Holland and Denmark agreed to a progressive reduction of tariffs in the hope that other countries would follow their example. The Ouchy Convention has failed entirely in its object. Belgium has been losing trade, and is now confronted with problems that can only be solved by a modification of her economic policy. An influential committee has been investigating the situation, and has presented to the Government a report which affirms that Belgium is unable, for reasons of internal prices, to adopt an integral system of Protection, though in view of the discrepancy in values of imports and exports it has become necessary to apply a system of strict reciprocity. The way is being prepared for reciprocal agreements which may possibly become less strict in their application on a return to sound economic conditions. There are obviously great difficulties in carrying out such arrangements, because most countries are not able to offer sufficient compensation for the advantages they hope to obtain. The announcement in the French Chamber of Deputies that the country is prepared to collaborate internationally in industrial and commercial adjustments with a view to avoiding the "perils that surround us" is happily an indication that something may be attempted without undue delay.

Literature.

◆

Works Management Education, with Special Reference to the Case System. By T. H. Burnham, B.Sc., B.Com., A.M.I. Mech. E. London: Sir Isaac Pitman and Sons, Ltd. 1933. Price 7s. 6d. net.

After perusing this work we are left with the definite impression that in the art of management the days of undirected natural evolution, those days when it was usual to adopt a *laissez faire* attitude, have for ever passed, and it is now recognised that management has become a profession in itself, the aim of which is "to guide an undertaking towards its objection with the greatest economic use of the available resources, both human and material."

If this be admitted, there can be no doubt that time and trouble devoted to the education of staff will be fully warranted.

In dealing with professional training for managers (Chapter I.), the author rightly affirms that most of the essential qualities of a manager, such as personality, leadership, and initiative, cannot be taught, but he claims that they can be trained and developed, although no rigid curriculum can be advocated. We are glad to see that it is asserted that as management is essentially practical, contact with industry must always be maintained, while the training will probably have to be varied to suit the locality.

Although there are not many educational centres where there is a thorough scheme of management training, at the South-East London Technical Institute a full course has been established, which is described in Chapter II. This includes not only a syllabus of lectures and mind training, but also what is called the "Case System" course. Each "case" is a definite management problem, usually obtained from some firm in the locality, and it is carefully considered by the class, which for the occasion is turned into a management committee, with the teacher in the chair. The case has been circulated several days in advance, and the works manager or other representative of the firm which made the suggestion is usually present at the meeting. The problem is discussed fully and freely, until a solution is reached and stated. The manager who has set it thereupon criticises what has been done, and proceeds to tell the students what course he actually adopted, giving his reasons. It will readily be realised that the co-operation of industry is essential to the success of such a scheme of training. Visits to the works in question are frequently arranged as a sequel to the case.

A plea for the organised diffusion of management knowledge constitutes Chapter III., and with this subject is closely associated the work of the Institute of Industrial Administration.

But if the manager needs training it becomes imperative that those on the lower rungs of the industrial ladder should also receive instruction, and so be ready to advance when opportunity arises. Chapter IV. deals with the important subject of modern foremanship training, and rightly emphasises the changed conditions that are now found in the world of manufacture. No longer is the foreman merely the skilled craftsman, expert at his particular trade, but his functions are increasingly administrative, and he becomes the important link between a number of highly specialised functions. He will always be the intermediary between men and management, with the result that the *esprit de corps* in a factory is largely in his hands, and by him the whole atmosphere of the shop may be made or marred. Considerations of this nature emphasise the necessity for training the foreman to be progressive and permeable to new ideas, as well as developing his own, and it is satisfactory to know that many technical institutes, with the assistance of local firms, arrange courses to meet this need.

Mr. Burnham has clearly made his case for management education, and in his first appendix is laid out a lecture course syllabus, covering nine main sections dealing with economics and business organisation, and thirteen with production and works management.

Appendix II., which occupies half the book, gives thirty-six different "cases" set out for consideration, the salient features being clearly enunciated, and finally the problem is stated. No solutions are given, the author's reason being that "it is impossible to reproduce them as they were progressively evolved by the students, and given orally by the managers, who were actually confronted by the problems as they arose in practice." While we appreciate his difficulties, we cannot help feeling that it would be distinctly helpful to set out at least one case in considerable detail, showing how the students arrived at their solution, and comparing it with the course actually pursued by the management of the firm concerned, explaining the reason for the difference between the two if there should be one. We should also be interested to hear if the industrialist ever confesses that the solution proposed by the students of management, who have had all the advantages of lectures and training, is definitely superior to the course he adopted.

This little book cannot be regarded as a textbook on management training, as its main object is to explain the developments in the application of the "Case System" of education in this country, and though a study of it might not make a young man a better manager, it would at least emphasise the necessity for a systematic course of study and indicate the best manner of securing it efficiently.

In our opinion perhaps the best feature of the author's proposals is to be found in his insistence on the maintenance of the closest co-operation between industry and the class room. Too often has a promising scheme—or even institution itself—started well, only to fall into the hands of the advanced theorist, the course becoming increasingly academic, until eventually it ceases to fulfil the function for which it was originally intended.

In his foreword, Mr. E. S. Byng, who is Chairman of Council of the Institute of Industrial Administration, welcomes this book as the first British "Case System" publication, and rightly stresses the importance of studying in the environment of British industry. We are in full agreement with him in his conclusion that the appearance of this volume is peculiarly opportune as a starting point for discussion, as a number of professional bodies are now paying more attention to this phase of the subject. It is considered that this work is more likely to be of value to technical institutes than to the individual.

SHORT NOTICES.

Commercial Cinematography, for Business and Commerce, Using Sub-standard Films. By George H. Sewell. London: Sir Isaac Pitman and Sons, Ltd. 1933. Price 7s. 6d.—The arrival of the 16 mm. and 9·5 mm. cinematograph films and cameras has so reduced the cost of production, and the price and bulk of apparatus, that their use is rapidly becoming a recognised form of trade publicity. The subject is now one on which the publicity departments of manufacturing firms must be informed, and it is for them primarily that this book has been written, but there is much in it that the amateur cinematographer should find useful. The author remarks that "the making of films consists of one part photography and nine parts picture making." It is probably rarely that engineering firms will go to the trouble of doing their own developing and printing—which can be done so much better by specialists—but they can with advantage take their own pictures. Mr. Sewell therefore devotes his attention to the apparatus and its use for picture taking and making, for film editing, projecting and so on. The volume may be recommended for purchase by publicity departments.

BOOKS RECEIVED.

Vectors for Electrical Engineers. By E. Mallett, D.Sc., &c. London: Chapman and Hall, Ltd., 11, Henrietta-street. W.C.2. Price 13s. 6d. net.

The Calculus of Finite Differences. By L. M. Milne-Thompson, M.A. London: MacMillan and Co., Ltd., St. Martin's-street, W.C. Price 30s. net.

The Gyroscopic Stabilisation of Land Vehicles. By J. F. S. Ross, B.Sc., &c. London: Ed. Arnold and Co., 41, Maddox-street, W.1. Price 14s. net.

The Elements of Reinforced Concrete Design. By H. C. Adams, M.A. London: Concrete Publications, Ltd., 20, Dartmouth-street, S.W.1. Price 6s. net.

Radio Upkeep and Repairs for Amateurs. By A. T. Witts, A.M.I.E.E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.1. Price 5s. net.

Automobile Electrical Equipment. By H. P. Young, O.B.E., and L. Griffiths. London: Iliffe and Sons, Ltd., Dorset House, Stamford-street, S.E.1. Price 15s. net.

Deep Sea Salvage. By A. Gowans Whyte, B.Sc., and R. L. Hadfield. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street, S.E.1. Price 10s. 6d. net.

Mathematics for Students of Building. Book II. By F. E. Drury, M.Sc., and W. T. Haslam, B.Sc. London: Ed. Arnold and Co., 41, Maddox-street, W.1. Price 5s. net.

Mineral Resources of the United States, 1930. *Part I.: Metals.* Washington: Superintendent of Documents, United States Government Printing Office, D.C. Price 1·50 dollars.

The Alloys of Iron and Silicon. By E. S. Greiner, J. S. Marsh, and B. Stoughton. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 30s. net.

Aircraft Performance Testing. By T. Scott Hall, M.Sc., and T. H. England, D.S.C., R.F.C. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 15s. net.

Correction Tables for Use with Platinum Resistance Thermometers. By G. S. Callendar and F. E. Hoare, Ph.D. London: Ed. Arnold and Co., 41, Maddox-street, W.1. Price 1s. net.

Technical Thermodynamics. By Professor Dipl.-Ing. W. Schüle. Translated by E. W. Geyer, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 40s. net.

Electrical Engineering Practice. Fourth edition. Vol. III. By J. W. Meares, C.I.E., &c., and R. E. Neale, B.Sc., &c. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 30s. net.

Metallurgical Analysis by the Spectrograph. By D. M. Smith, A.R.C.S., B.Sc., &c. London: British Non-Ferrous Metals Research Association, Regnart Buildings, Euston-road, N.W. 1. Price 10s. 6d. net.

The Vitry Locomotive Testing Station.

◆

THE Office Central d'Etudes de Matériel de Chemins de Fer was constituted in 1919 by the seven French railway companies with a view, primarily, to preparing plans for standardising rolling stock. The nature of the work undertaken by the Office Central had the logical result of making it a centre of technical research in everything relating to locomotives, wagons, and railway material generally. The difficulty in the way of investigating problems of locomotive efficiency by means of the more or less unreliable data obtained from tests in actual service induced the principal engineer of the O.C.E.M., Monsieur Place, to propose the construction of a fixed testing plant. Plans for such a plant were begun in 1920, but it was not until 1929 that the railway companies were able to grant the credits necessary to put the work in hand. The site chosen for the installation is at Vitry-sur-Seine, where a building—illustrated on page 462—180ft. long and 49ft. wide was erected to house the plant. Outside this building are two reservoirs, each of 400 cubic metres capacity, for water circulation to the Froude brakes. Adjoining it are offices, a laboratory, and a shed, connected with the Paris-Orleans railway, for the locomotives to be tested, and for four dynamometer coaches which the Office Central has constructed for the use of the railway companies. Ample space has been reserved for additional plant and buildings that may be necessary to make the Vitry experimental station as complete as possible for all kinds of railway research and testing work. A sum of 16,000,000f. was allotted for this important undertaking. It is understood that close upon 10,000,000f. were spent upon the test bench, most of the remainder being devoted to buildings. The bench was designed by the locomotive department of the O.C.E.M., and constructed by the Compagnie des Forges et Aciéries de la Marine et d'Homécourt, which also collaborated in the preparation of details.

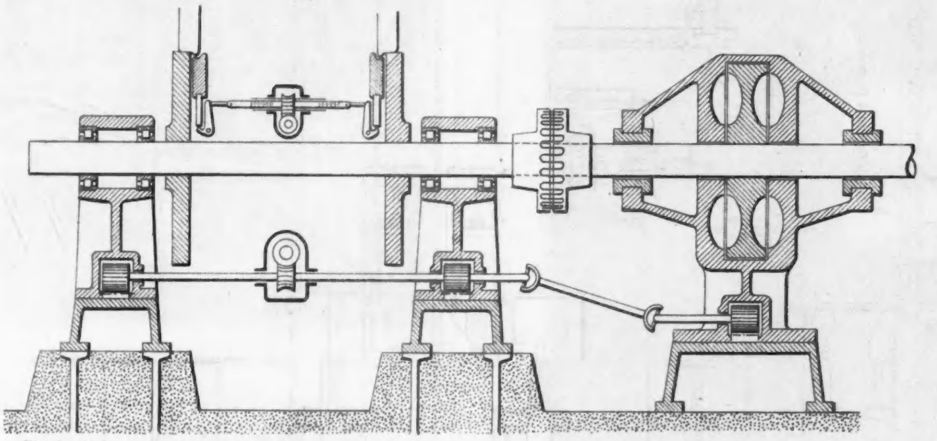


FIG. 5—CROSS SECTION OF TEST BED

The building containing the plant is a steel frame and brick structure with heavy girders capable of carrying eventually two overhead travelling cranes of 60 tons, although at present only one 25-ton crane is installed. The foundation for the bench—see Fig. 5—is composed of deep girders laid in concrete. The total length of the foundation is 105ft., and provides for a possible extension of the existing locomotive platform, which is 82ft. long. It carries two tracks built up of heavy double-tee cast iron sections planed on the top and along the edges. The sections are bolted together and each forms a wide tread with a central rack, on which are mounted pedestals carrying rollers driven by the locomotive wheels. Each pedestal has a pinion meshing with the rack, as well as small rollers that bear on the smooth surfaces on each side of the rack to take the weight of the pedestal while it is being moved. When the pedestal is bolted down to the bench for testing purposes, Belleville washers against which the rollers bear are compressed and the load is transmitted direct to the track. Each driven roller is composed of two wheels mounted on an axle. The wheels have a diameter of 1·3 m. and flat rims 140 mm. wide, and are set apart to accommodate locomotives with a minimum distance between driving wheel centres of 1·45 m. The roller wheels are keyed on axles 270 mm. diameter, carried in double-roller bearings mounted in spherical housings. These bearings also take up axial thrust. Each roller is connected by a Wellman-Bibby coupling to a Froude brake, capable of absorbing 1200 horsepower. The rollers and brake, when free on their beds, have been run at 800 revolutions per minute without showing the slightest vibration. The size of the brakes necessitates their being placed alternately on each side of the locomotive platform, so that there are two brake tracks each with a central rack. As the whole weight of the brake rests directly on the track, considerable friction has to be overcome in moving it. The pinion for adjusting the position of the Froude brake is connected by a cardan shaft with the pinion shaft of the roller pedestals, and the brake and roller are moved simultaneously. All the roller and brake units can be displaced simultaneously or separately by means of a longitudinal shaft extending the whole length of the bench and driving worm gears on the pedestal pinion shafts through dog clutches. Each clutch is put in and out of engagement by the agency of a hand wheel operated from the side of the pedestal. The longitudinal shaft is driven by a 23 horse-power electric motor through reduction gearing, which gives a very slow motion to the heavy masses to be moved.

There is a second longitudinal shaft from the same electric motor for raising and lowering the locomotive platform which is supported on cross members and jacks, these latter being given a travel of 30 mm. by the rotation of the shaft. The platform is provided with rails on which run the flanges of the locomotive wheels, while the treads overlap the rollers. Before the platform is lowered to bring the locomotive wheels on to the rollers, these latter have their distances apart adjusted to equality with those of the locomotive wheels with the aid of pointers on the roller pedestals and a scale graduated in millimetres extending the whole length of the bench. Precision of the adjustment of the rollers relatively to the wheels is obtained by means of a centering plate—see Fig. 6—consisting of a balance beam pivoted at its centre and carrying small rollers at its extremities. The small rollers rest on the wheel of the driven roller, and the beam is adjusted horizontally with the aid of a water level. It is then raised vertically by a lever until the small rollers bear against the rim of the driving wheel. Any deviation of the beam from the horizontal when it is raised is amplified by a pointer working against a graduated quadrant. Verification of the position of the wheels relatively to the rollers can be carried out at any moment during the test. The platform is next lowered 15 mm. to bring the driving wheel treads on to the rollers, and then descends another 15 mm. to clear the flanges.

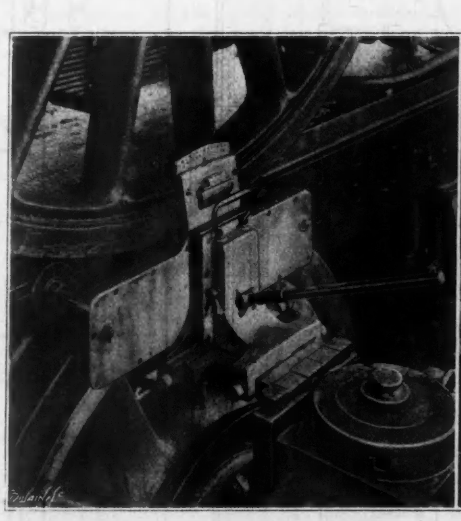


FIG. 6—WHEEL LOCATION INDICATOR

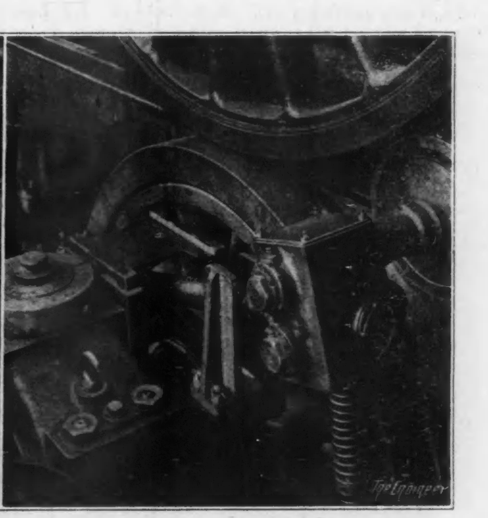


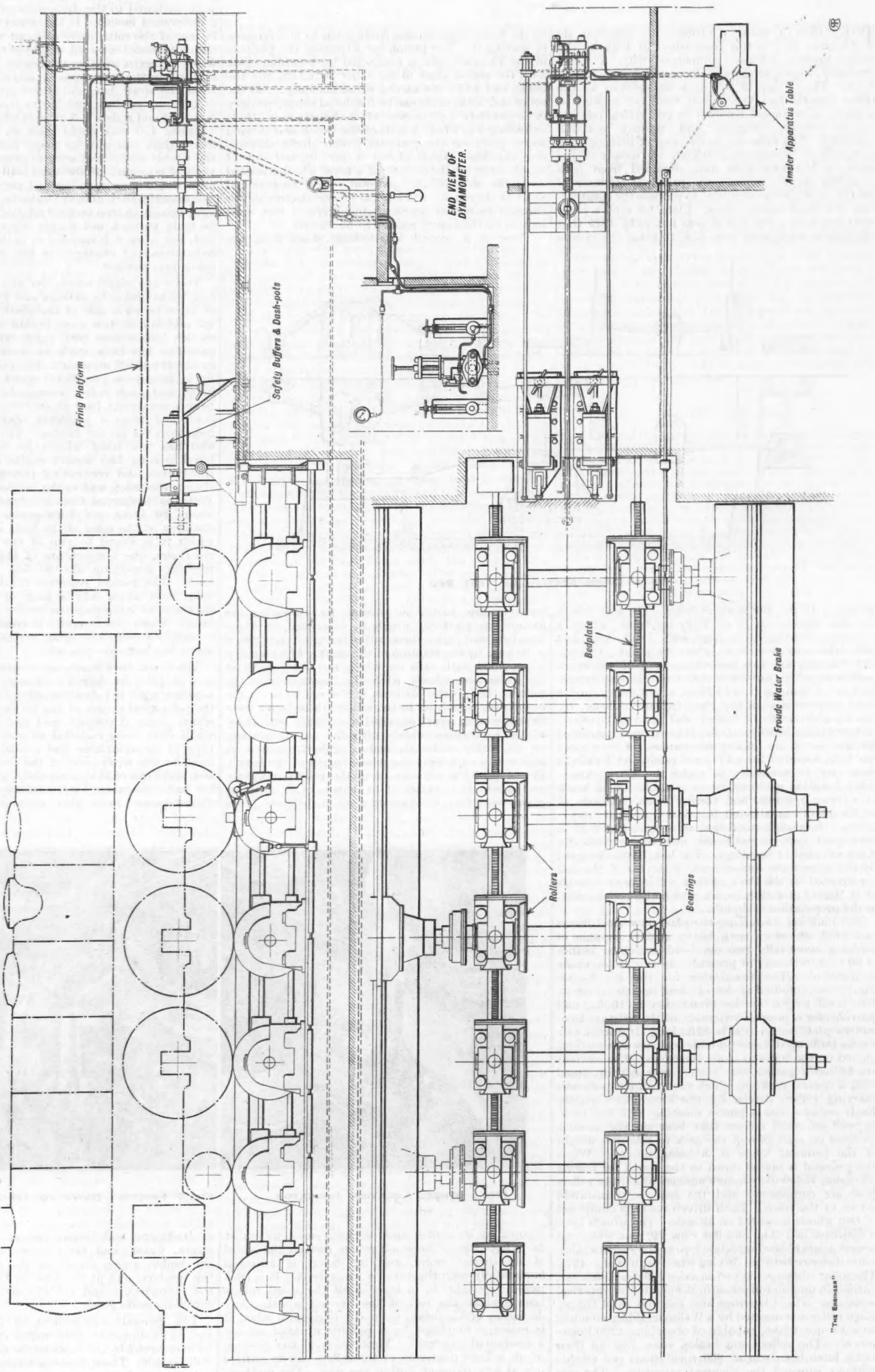
FIG. 7—FRICTION DRIVE TO APPARATUS TABLE

It is to be noted that the exact adjustment of the rollers vertically beneath the locomotive wheels is of great importance to the accuracy of the test results. If the wheel axles are slightly in advance of the roller axles, the weight of the engine will by itself exert a pull on the dynamometer just as it would if the engine were anchored to the dynamometer and were set on a downward incline. If the wheel axles are slightly in rear of the roller axles a thrust will be exerted on the dynamometer by the weight of the engine. These forces will exist whether the engine is idle or running, and will in the latter case be added to or subtracted from the draw bar pull developed by the engine. It is estimated that, with locomotive wheels of 1·5 m. diameter and rollers 1·3 m. in diameter, a locomotive weighing 100 tons would show an error of 71 kilos. in the draw bar pull for every millimetre by which the wheels and rollers were displaced from the truly vertical position. If the total pull were 7 tons, this error would amount to one of 1 per cent. It is therefore essential to be able to locate the wheels and rollers very exactly in true vertical relationship. They must be truly vertical, not simply when the engine is at rest, but when it is running in order that play in the axle-boxes and elasticity in the draw bar may be taken into account.

There are eight rollers on the bench. Six are coupled to brakes by Heenan and Froude, Ltd., three of them on each side of the platform, so that with the addition of two more brakes it will be possible to test locomotives with eight driving axles, while provision has been made to increase that number in the future, if necessary. The rollers are designed for a maximum peripheral speed of 100 miles an hour, and each roller, representing one axle, will bear a maximum load of 30 tons. The brakes are controlled from a platform equipped with speed indicators for all the brakes. The control platform also has two hand wheels for operating through bevel gearing two square shafts running along to the brakes and controlling through sprockets and chains the inlet and outlet orifices of the brakes. Water is discharged from the brakes at the rate of about 20 litres per horse-power per hour along channels at the sides of the beds into a sump from which it is raised to one of the 400 cubic metre reservoirs, the temperature of the discharge water reaching something like 80 deg. Cent. under full load. The second reservoir of the same capacity feeds cold water into a tank of 30 cubic metres capacity for supplying the brakes under a constant head. When this reservoir is empty the small tank is supplied from the other reservoir in which the water has had time to cool.

The 45-ton draw-bar dynamometer, see Fig. 3, p. 462, was supplied by Alfred J. Amsler, of Schaffhausen, together with the dynamometer table for recording the peripheral speeds of the driving wheels, tractive effort, power developed, and useful work done, the whole data being recorded on one sheet. The same type of dynamometer and similar instruments are used for the equipment of the four cars, one of 90 tons and three of 45 tons capacity, which the O.C.E.M. has had constructed for the railway companies. The dynamometer room also contains a complete set of Hoffmann and Braun instruments for recording steam, water, and air temperatures; pressure in the boiler, steam chest, at the exhaust ports, in the fire-box, and at the base of the chimney; and the temperature and the CO and CO_2 contents of the combustion gases.

The general arrangement of the dynamometer and its relationship to the engine on the test bed will be understood by reference to the drawing reproduced on page 466. The dynamometer makes use of a single cylinder employing oil as the working fluid and designed to register pulling efforts only. If it is desired to test the tractive effort of an engine running backwards, it has to be run on to the test bed with its front end towards the dynamometer. The dynamo-


Firing Platform
Safety Buffers & Dash-pots
END VIEW OF DYNAMOMETER.
Amsler Apparatus Table
Bedplate
Froude Water Brake
Rollers
Bearings
"The Engineer"

THE VITRY-SUR-SEINE LOCOMOTIVE TESTING PLANT meter is constructed to withstand a pull of 45 tons, but it can be subjected with safety to momentary efforts up to 70 tons.

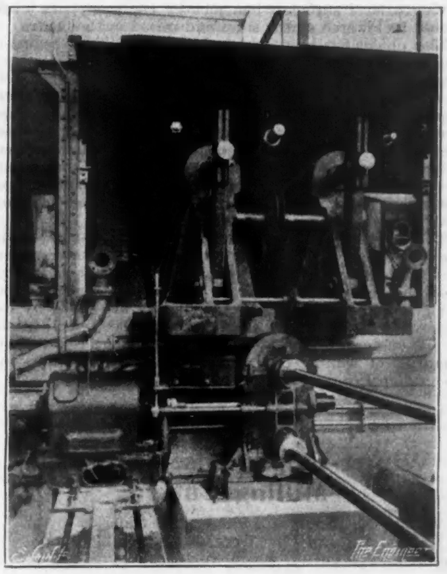
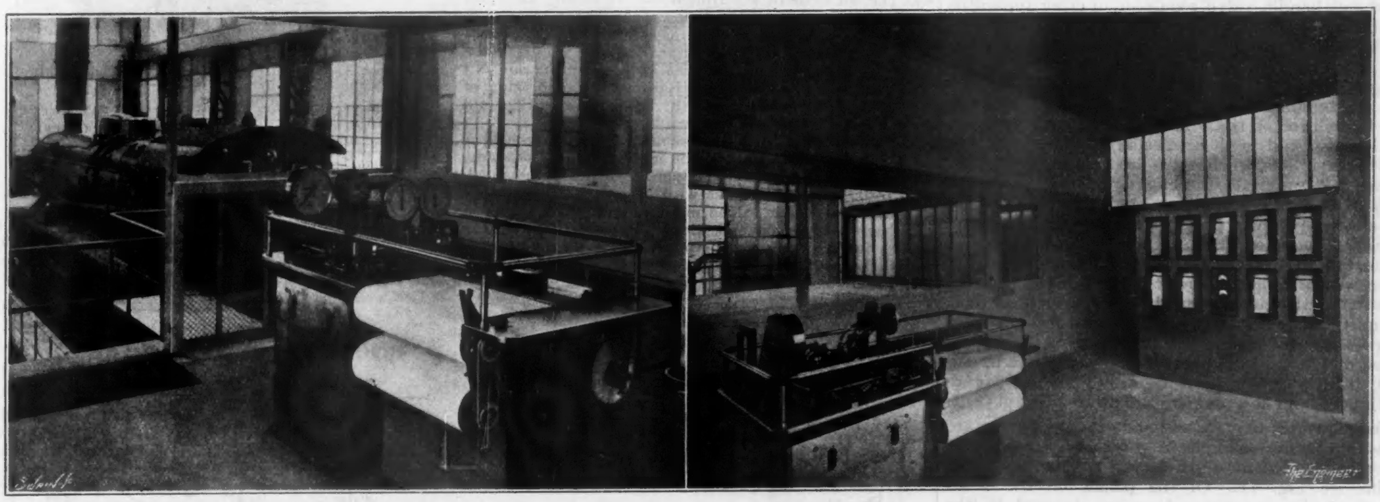


FIG. 8—SAFETY BUFFERS AND DASHPOTS



FIGS. 10 AND 11—TWO VIEWS OF THE RECORDING ROOM

The dynamometer cylinder contains a piston ground to fit with a degree of precision sufficiently great to permit packing to be completely dispensed with. In these circumstances the friction is of negligible amount, and the oil pressure set up within the cylinder becomes a measure of the pulling force exerted on the dynamometer. The cylinder bears against the rear side of a vertical beam embedded in concrete and connected to an anchoring frame which is in metallic connection with the steel work in the foundations of the test bed. The tractive effort is transmitted from the engine to the cylinder by means of a long draw bar coupled by a screwed sleeve to a short additional length which terminates in a spherical head. This head engages with a corresponding seating in the end member of a horizontal frame, the other end member of which forms one of the abutments—the face of the vertical beam being the other—between which the dynamometer cylinder is situated. The two rods constituting the side members of the horizontal frame are supported on rollers within a cast iron cradle within which they may slide easily, and by which the horizontal frame is suspended from a stirrup arranged over the top of the vertical beam. A hand wheel and screw enable the cradle and horizontal frame to be adjusted to a varying height to suit the level of the draw hook of the engine under test. The dynamometer cylinder slides against the rear face of the vertical beam and partakes of the adjustment. Parallel with the long draw bar two safety rods extend from the buffer beam of the locomotive to two vertical posts rising out of the concrete behind the vertical beam and in metallic connection with that beam. These rods are provided to prevent mishap in the event of the draw bar fracturing. Both the rods and the draw bar are provided with means for supporting them at a varying height. The oil from the cylinder is led to the pressure-measuring equipment on the adjacent apparatus table by means of hinged pipes, which accommodate themselves to changes in the vertical position of the cylinder and the cradle and frame.

Means are provided to make good any loss of oil by leakage between the piston and cylinder during a prolonged test under the influence of the force which is applied constantly in the one direction. To prevent the slow recession of the piston, and the consequent displacement of the locomotive on the rollers, a small piston pump with a very small delivery is provided. This pump is driven through reduction gearing by an electric motor, and is capable of forcing oil into the cylinder no matter what pressure may be in existence therein. Normally, this pump is short-circuited by means of its suction valve, and runs idle. As soon as any movement of the locomotive and the piston away from the position of initial adjustment occurs, a contact on the horizontal frame of the dynamometer operates a rod, and thereby closes the short circuit through the suction valve of the pump. The pump then delivers oil to the cylinder and returns the piston and the locomotive to the initially adjusted position. Immediately that position is recovered the pump is once more short-circuited. It is stated that the system is sensitive to a fraction of a millimetre of movement, and that the restoration of the oil lost by leakage is accomplished by it without a perceptible rise of the oil pressure in the cylinder.

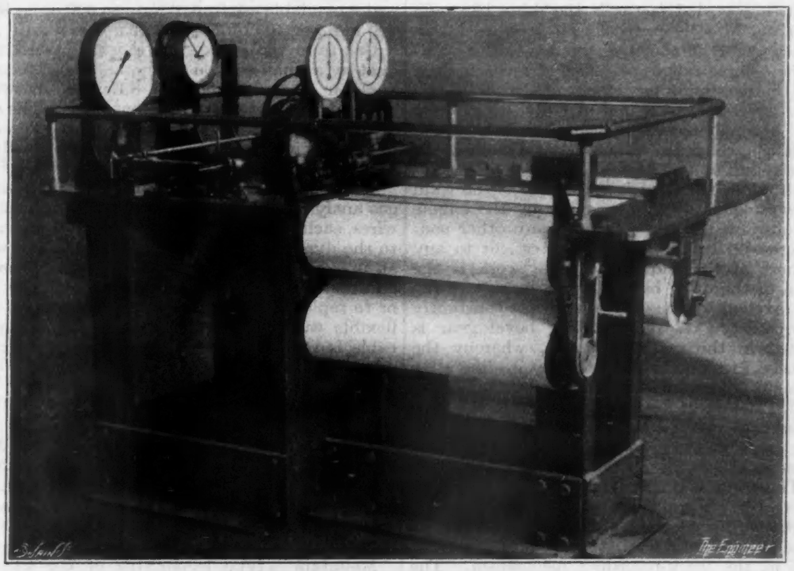


FIG. 9—AMSLER APPARATUS TABLE

Two dash pots are provided on supports anchored to the foundation immediately in rear of the engine, and are designed to suppress horizontal oscillations set up by want of balance in the reciprocating parts of the engine. As will be gathered from Fig. 8, the buffers by which these dash pots engage with the rear of the engine are adjustable as regards height to accommodate different designs of locomotive.

The calibration of the dynamometer cylinder is effected by uncoupling the draw bar at the screwed sleeve and by inserting an Amsler standardising block between the front face of the vertical beam and the end piece of the horizontal frame. The small compensation pump is then caused to deliver oil to the cylinder until any desired load is set up. The value of this load as measured by the standardising box is then compared with the indication of the recording device on the apparatus table.

Passing now to the apparatus table, we will describe the manner in which the information which it is desired to obtain is transmitted to it and there recorded. The speed of the locomotive is obtained by means of a friction disc, Fig. 7, held by a pressure spring against the tread of one of the wheels. This disc is carried on a pivoting frame attached to the bearing of one of the wheel rollers. It is exactly 1 m. in circumference and therefore rotates 1000 times per kilometre of the supposed distance run by the locomotive, no matter what may be the diameter of the wheel with which it is in contact or the degree of wear which its tire has suffered. The rotation of the disc is transmitted through shaft and gearing to a horizontal splined shaft running the full length of the test bed and from this shaft the movement is taken by further shafts and gearing to the apparatus table.

At the apparatus table—see Figs. 9 and 10—a record is made of six different factors. The six recording pens operate on a roll of paper 650 mm. wide, which can be set to move either proportionately to the "distance travelled" by the locomotive or proportionately to the time. In the first-named condition the movement of the paper is derived from the friction disc, Fig. 7, and may be set at either 4 mm., 20 mm., or 120 mm. per kilometre. In the second condition the paper is driven by an electric motor with a constant speed regulator, and its rate of movement may be either 0·2 mm., 1 mm., or 6 mm. per second. On this roll the first factor, that of time, is recorded by two electro-magnetic pens, one operated by a clock and drawing a mark once every minute, and the other operated by a small constant-speed electric motor, and making a mark every 2, 6 or 12 seconds. The second factor recorded is the "distance travelled" by the engine. The recording pen in this case is operated from the friction disc bearing against the engine wheel, and makes one mark for every 1000 turns of that disc; that is to say, for every kilometre travelled by the engine.

The third factor is the speed of the engine in kilometres per hour. This factor could, of course, be deduced from the information concerning time and distance run, given by the first and second pens. It is, however, recorded separately by means of an Amsler differential ball speedometer. This form of speedometer is claimed to work with very high accuracy. Its operative element consists of a steel ball, about 4in. in diameter, which is supported on the peripheries of two rotating discs having their planes at right angles to each other. One of these discs is driven at a speed proportional to that of the engine. The other is driven at a constant speed by a small electric motor—the same motor, in actual fact, as that which marks the seconds divisions on the time curve. Assuming that there is no slip between the discs and the sphere, the sphere will acquire from the two discs a rotation about a certain axis, the inclination of which relatively to the axis of one or other of the discs is dependent upon the ratio of the speeds of the two discs. Thus by observing the inclination of the axis of rotation of the sphere, and knowing the speed of rotation of the constant velocity disc, the speed of the other disc and therefore of the engine can be found. Means are provided for recording the speed on the paper and also for indicating it on a dial.

The fourth recorded factor is the draw bar pull, and is derived directly from the oil pressure transmitted from the dynamometer cylinder to the apparatus table. Three ranges or scales of recording are provided, the maximum movement of the pen corresponding respectively to a pull of 6, 15, or 45 tons. The draw bar pull is also indicated on a Bourdon pressure gauge, which can be used to read momentary values of the pull up to 75 tons.

The fifth factor recorded on the paper is the total effective work done at the draw bar by the engine from the start of the test—or from any other convenient zero—up to the end of the test, or to any instant short of the end. This total work is the integration of the draw bar pull with respect to the distance travelled by the engine, and is a constantly growing quantity. A reciprocating bevel gear is incorporated in the pen mechanism, whereby the pen is caused to move back to the datum line after every so many kilogramme-metres of work have been performed. The curve drawn is therefore in the form of a zig-zag confined to a limited width of the paper, about 3in., and does not, as it would otherwise have to do, extend slantwise continuously across the full width. The total work done up to any instant is determined by counting the number of zig-zags. As a check, and for purposes of taking rapid readings during the progress of a trial, a four-figure counter is embodied in the work-recording mechanism. The scale of this counter and also the scale of the zig-zag curve depends upon the scale in use in connection with the measurement of the draw bar pull. The actual integration of the draw bar pull with respect to distance travelled is performed by an Amsler ball pattern integrator.

The sixth and final factor recorded is the draw bar horse-power or the integration of the work done at the draw bar with respect to time. The integration is performed by an arrangement similar to that used in the speedometer, namely, by means of a sphere resting on the peripheries of two discs. One of these discs, as before, is rotated at a constant known speed, while the other is rotated at a speed determined by the apparatus which records the work done at the draw bar. A dial gauge is also provided to indicate the momentary value of the horse-power. One complete revolution of the pointer of this gauge corresponds to a horse-power of 1200, 3000 or 9000, according to the draw bar pull scale in use.

In addition to the six pens recording the above-mentioned data, a number of other pens are provided which may be used to record the instants at which any handle, valve, regulator, or other apparatus on the engine is operated.

The firing platform is arranged above the long draw bar and can be adjusted in height to suit different designs of engine. The coal weighed in the yard outside the building is brought inside in small trolleys, which are lifted on to the firing platform by the overhead crane, and is there discharged into a bunker moving on rollers, whence it is fired to the locomotive.

The feed water for the engine is supplied from a tank of 10 cubic metres capacity, which is filled by the alternate emptying of two tanks, each of exactly 1 cubic metre capacity. One of these tanks is graduated in litres. The 10 cubic metre tank is fitted with a gauge, whereby the water in it can be restored at the end of a trial to the same level as it occupied at the start. In addition, for checking purposes, water meters are provided on the mains. These meters, of the volumetric, piston pattern, can deal with water at a pressure of 30 kilos. per square centimetre, and at a temperature up to 235 deg. Cent.

Temperatures at various points on the engine are measured by means of electric resistance pyrometers, and are recorded on apparatus in the dynamometer cabin—see Fig. 11. Of the panels on the board shown in this engraving four are devoted to the recording of temperatures. Each of these four recording panels contains a cross-coiled galvanometer which every 10 seconds is automatically connected in succession to six pyrometers. At each connection a pen containing a different-coloured ink is operated. In this way, each of the four recording panels yields six distinguishable temperature curves on the one chart, the individual curves being composed of a succession of closely spaced dots. Two of the recording panels are devoted to the measurement of the temperatures of the hot gases at various points in the fire tubes and smoke-box. These two panels have two scales, one extending from 100 deg. to 300 deg. Cent., and the other from 200 deg. to 600 deg. Cent., a commutator being provided which allows either scale to be used at will. A third recording panel is reserved for measuring air and water temperatures, and has two alternative scales, namely, from 0 deg. to 160 deg. Cent. and from 0 deg. to 320 deg. Cent. The fourth recording panel measures saturated and superheated temperatures. It has two scales extending from 0 deg. to 250 deg. Cent. and from 150 deg. to 500 deg. Cent.

Pressures above and below atmospheric are measured by gauges placed at various points on the engine. The indications of these gauges are transmitted electrically to the dynamometer cabin, and are there recorded by means of apparatus similar to that used for recording temperatures. The six-curve pressure recorder has three alternative scales, namely, from 0 to 1·5, 0 to 10, and 0 to 25 atmospheres. In the case of the vacuum recorder, the scales available are from 0 mm. to 500 mm., 300 mm., 200 mm., or 100 mm. of water.

Gas from the smoke-box is withdrawn through a duct by a small suction pump, and delivered to a gas analyser operating on the difference between the thermal conductivity of different gases. The analyser gives the percentage of CO_2 and $CO+H_2$ present in the gases. Its indications are recorded electrically on the board in the dynamometer cabin.

In connection with the temperature, pressure and gas analysis recorders there are no fewer than ninety wires, each of 50 m. length, extending from the engine to the dynamometer cabin. Some of these wires are at present not in use, but are held in reserve for additional apparatus that may eventually be installed or to replace breakages. They are grouped into five flexible cables of eighteen wires each. Each such cable is provided with a special design of coupling, whereby all the eighteen connections can be made quickly and certainly.

At the inauguration of the laboratory on July 27th last a large party of railway engineers and directors of railway companies was received by Monsieur Renevey, director of the O.C.E.M., and Monsieur Conte, chief engineer, while Monsieur Place, to whom credit was given by Monsieur Renevey for what he had done to bring the undertaking to a successful issue, conducted a demonstration with a "Mountain" type locomotive of the Chemins de Fer de l'Est. The demonstration was carried through smoothly, the locomotive running at what was equivalent to 60 kiloms. and 120 kiloms. an hour. The Vitry testing station is available to all locomotive builders and railway companies.

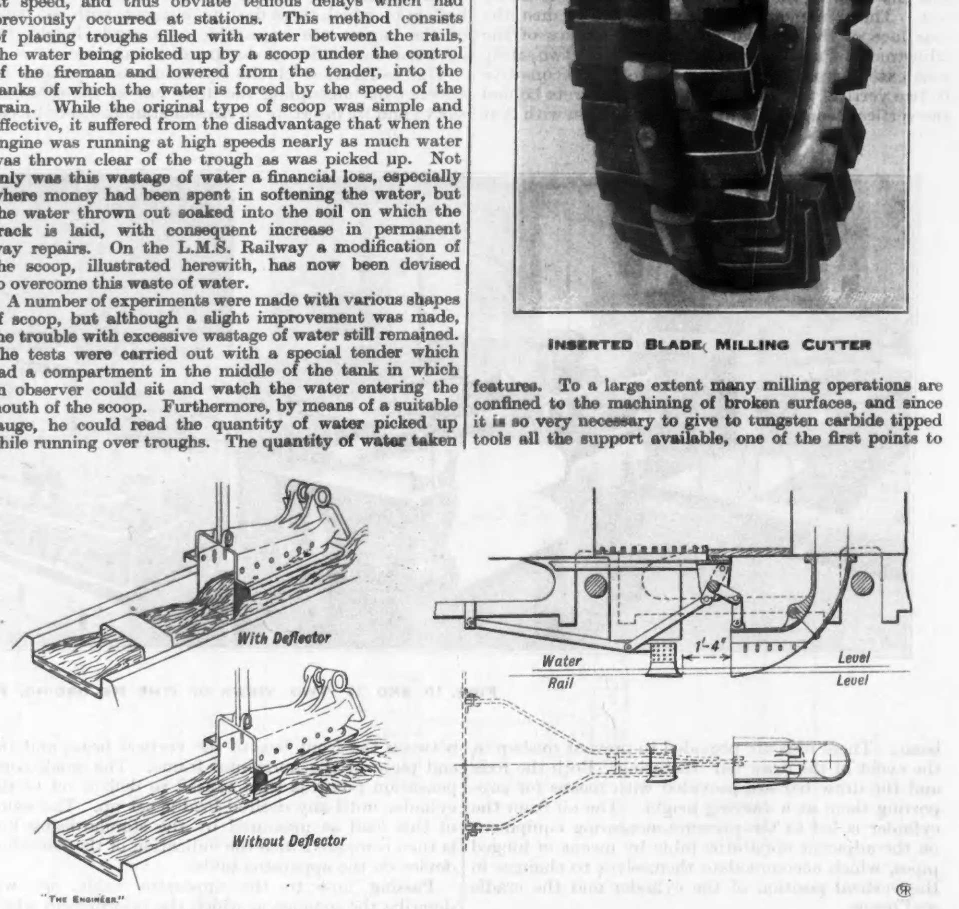
Improved Water Pick-up Gear, L.M.S. Railway.

IT is now more than seventy-five years since Mr. John Ramsbottom, locomotive engineer of the London and North-Western Railway, invented his well-known method whereby locomotives were enabled to pick up water while at speed, and thus obviate tedious delays which had previously occurred at stations. This method consists of placing troughs filled with water between the rails, the water being picked up by a scoop under the control of the fireman and lowered from the tender, into the tanks of which the water is forced by the speed of the train. While the original type of scoop was simple and effective, it suffered from the disadvantage that when the engine was running at high speeds nearly as much water was thrown clear of the trough as was picked up. Not only was this wastage of water a financial loss, especially where money had been spent in softening the water, but the water thrown out soaked into the soil on which the track is laid, with consequent increase in permanent way repairs. On the L.M.S. Railway a modification of the scoop, illustrated herewith, has now been devised to overcome this waste of water.

A number of experiments were made with various shapes of scoop, but although a slight improvement was made, the trouble with excessive wastage of water still remained. The tests were carried out with a special tender which had a compartment in the middle of the tank in which an observer could sit and watch the water entering the mouth of the scoop. Furthermore, by means of a suitable gauge, he could read the quantity of water picked up while running over troughs. The quantity of water taken from the troughs was determined by measuring the quantity of water which had to be put into the troughs to refill them to the proper level after the engine had passed over them. During the tests with the various shapes of scoop it was noticed that the water piled up on each side of the scoop and escaped over the edge of the trough. It, therefore, appeared that if the level of the water could be lowered between the scoop and the inside of the trough, the wastage would be reduced. It was not possible, however, to reduce the level of the water at the side of the trough by the simple expedient of having less water in the trough, as this would have reduced the quantity of water being picked up. In other words, it was realised that what was required was that instead of the water having a level surface when met by the scoop, its level should be lowered at the sides and raised in the centre.

This object has been achieved in a very simple manner by placing a deflector about 1ft. 4in. in front of the scoop, this deflector having two vertical vanes which project down into the water, the vanes being somewhat closer together at the back than at the front. As this deflector moves through the water in advance of the scoop, it has the effect of throwing the water inwards so that the water is heaped up at the centre of the trough and lowered at the sides, with the result that not only is the wastage reduced, but a larger amount of water is picked up than with the ordinary apparatus.

The deflector is raised and lowered simultaneously with the water scoop. Its effect on the wastage of water varies in accordance with the speed of the train, but assuming that the scoop is kept in for the whole length of the trough, then about 400 gallons of water are saved by its use every time water is taken. The device, when fitted to all engines with water pick-ups, should reduce the quantity of water which is supplied to the troughs by about 20 per cent.



ARRANGEMENT AND EFFECT OF IMPROVED WATER PICK-UP GEAR

Wimet-Tipped Inserted Blade Milling Cutter.

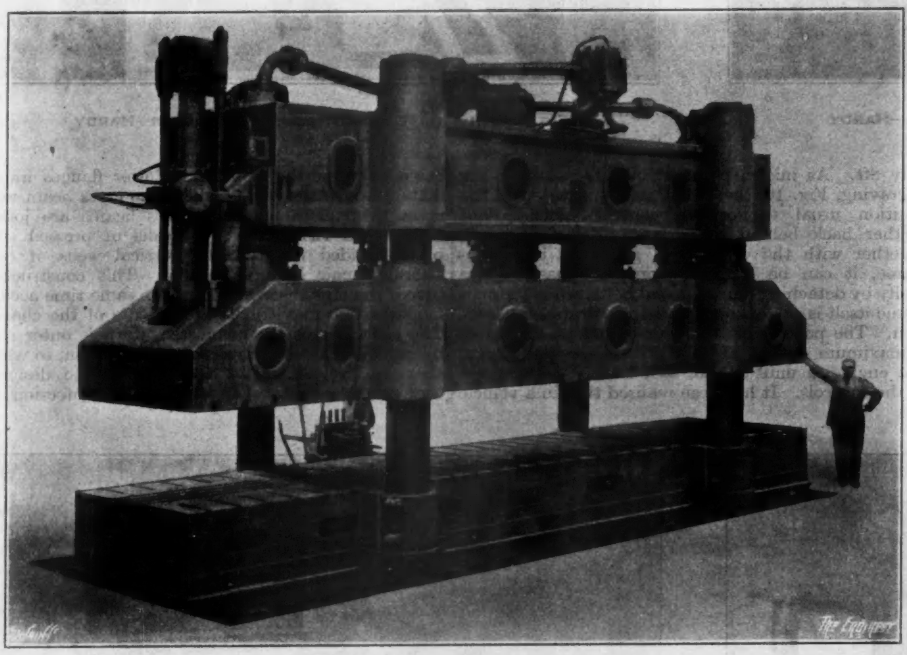
THERE has just been placed on the market by A. C. Wickman, Ltd., of Coventry, an inserted-blade, Wimet-tipped milling cutter, which embodies several interesting features. To a large extent many milling operations are confined to the machining of broken surfaces, and since it is so very necessary to give to tungsten carbide tipped tools all the support available, one of the first points to

INSERTED BLADE MILLING CUTTER

require attention in the design of a tipped inserted-blade milling cutter is a maximum number of blades rigidly supported and securely locked in the cutter body. Also, owing to the brittle nature and expense of cemented tungsten carbide, the finest possible individual adjustment must be provided to each blade. The clamping of the blades must be arranged to preclude any type of wedging action which might cause the body to distort and upset the rigidity of the cutters, or necessitate the use of force to remove tightly locked blades or clamping screws to the detriment of the cemented tungsten-carbide-tipped blades. The new design includes the simplifying of the clamping arrangement of the blades. It will be noted from the accompanying engravings that two blades are held in position by one clamp, and can be removed or adjusted by loosening one screw with a key. The shanks of the blades are provided with serrations which match serrations on the underside of the clamps. This arrangement makes the adjustment of the blades very simple, besides providing for a very rigid lock and support. Adequate chip clearance has been provided. The Wickman Wimet-tipped inserted-blade milling cutter is made in seven sizes from 3½in. to 10in. diameter; any special sizes can be made to order. The 10in. size contains twenty-six blades. Cutters up to 7in. diameter are made to suit standard arbors for face cutters, while cutters above 7in. diameter are arranged to be attached directly to the spindle of the American standard type.

A Large Hydraulic Press.

The large hydraulic press illustrated was made by Fielding and Platt, Ltd., of Gloucester, to the order of Rubery, Owen and Co., Ltd., of Darlaston, and has been specially designed for the pressing of heavy motor chassis for commercial and private vehicles of all kinds. It gives a load of 1500 tons, but where the work does not necessitate so high a pressure, it may be used at 900 or 600 tons respectively. The working faces of the tables are 30ft. long by 6ft. wide, and in the lower table are arranged ten ejecting rams, giving a total ejecting pressure of 200 tons. Holes are provided over the face of the bottom table for carrying the necessary discharge pins, so that any irregular shape of chassis can be dealt with. Water-saving valve arrangements are provided so that accumulator pressure water is only used to do the actual pressing operation; and automatic suspension gear is fitted for holding the moving table in the top position when pressure is shut off from press.

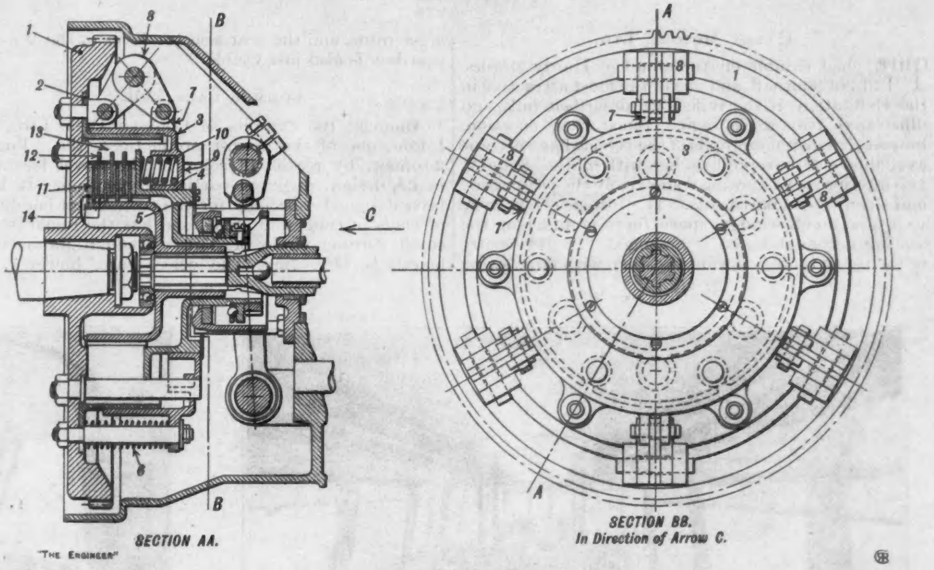


1500-TON PRESS FOR HEAVY MOTOR CHASSIS

Automatic Clutch for Motor Vehicles.

In our review of the leading features of the Motor Car Show at Olympia, in our issue of October 20th, reference was made to a new automatic clutch which is being fitted to the Riley cars. This clutch is the invention of Mr. Noel B. Newton, of Newton and Bennett, Ltd., Valetta-road, Acton, W.3, and depends for its operation on centrifugal force. Its construction will be followed by reference to the sectional drawing, in which 1 is the fly-wheel on which is mounted a steel sleeve 2. Sliding over this sleeve is a casting 3, usually made of a zinc alloy, which carries a central bearing 4, in which the presser plate 5 moves longitudinally, being held away from the fly-wheel by springs 6. The casting 3 carries bosses 7 to accommodate one end of the governor weights 8 and also spring cups 9 to receive the internal springs 10. The clutch proper is of the multi-disc type, having four inner discs 11 faced with Ferodo or other similar material. The outer steel discs 12 run on six hardened steel pegs 13, whilst the inner plates 11 slide on the spline 14.

The operation of the clutch is as follows :—The member 3 is moved towards the fly-wheel 1 by the influence of the centrifugal force set up by the governors 8 at a predetermined speed controlled by the static loading of the outer springs 6. After ¼in. of movement the presser plate 5 comes into contact with the friction discs 11, in the neighbourhood of an engine speed of 650 revolutions per minute. As the speed of revolution increases, the centrifugal force acting upon the governor weights 8 pulls up the inner springs 10, and the torque is overcome in the neighbourhood of 1100 revolutions per minute, when the member 3 becomes definitely engaged with the fly-wheel sleeve 2. This gives a load on the discs 11 and 12 of approximately one and a half times the necessary torque to be transmitted, and also allows for plate wear to be taken up by the inner springs 10 without altering the governor position.



SECTION AA.

SECTION BB.
In Direction of Arrow C.

AUTOMATIC CENTRIFUGAL CLUTCH FOR MOTOR CAR

The complete unit operates automatically, and if the car is fitted with a self-changing gear-box, there is no need for the driver to operate the usual pedals.

Centenary of Lancashire Engineers.

There are not many engineering firms that date back a hundred years, as is the case with Hick, Hargreaves and Co., Ltd., Bolton, which celebrated its centenary by a dinner in Manchester on Thursday, November 2nd. There are even fewer firms that can claim a more interesting experience as regards their products, which have covered a very wide range of mechanical engineering, including locomotives, marine engines, stationary engines, steam turbines, condensing plants, feed heaters, and air compressors.

The firm was founded in 1833 by Benjamin Hick, with the title of Benjamin Hick and Son. Hick served his apprenticeship with Mathew Murray, Leeds, one of the leading firms of engineers at that period. He subsequently left Leeds to join Messrs. Rothwell and the firm of Rothwell, Hick and Rothwell was formed. At the age of forty-three Hick severed his connection with this firm to establish a business with his two sons on the site of Hick, Hargreaves' present premises. The new firm of Benjamin Hick and Son soon earned a high reputation as power engineers and, like other engineers in those non-speculative days, had to be prepared to undertake work of every description for use in factories, mines, railways, and for marine purposes.

Benjamin died at the age of fifty-two in the year 1842, and his elder son John took over the business, along with Mr. William Hargreaves, and the title of the firm was changed to Hick, Hargreaves and Co. Under the joint management of these engineers the firm made good headway. In 1868 John Hick turned his attention to politics and was elected Member of Parliament for Bolton, and retired from the firm and William Hargreaves became sole proprietor, which he remained until his death in 1889, when the business was converted into a private limited company. It was carried on by his three sons, each successively becoming chairman of the board of directors.

One of the earliest activities was the construction of locomotives, of which a large number was built between 1833 and 1855, the drawings of many of which are still in existence. In 1850 the building of marine engines was undertaken, and amongst the orders executed were two sets of simple direct-acting jet condensing paddle-wheel engines for H.M. steam frigates "Alphonse" and "Amazonas," the cylinder diameters of which were 68in., the stroke 60in., and the rated horse-power 300. These were followed by two sets of simple direct-acting inverted screw propeller engines for the Mediterranean steamers "Nile" and "Orontes," with cylinders 47½in. diameter and 54in. stroke. But it is in connection with mill engines that Hick, Hargreaves and Co. were chiefly identified. By the introduction of the Corliss valve gear applied to horizontal slow-speed engines, the firm made a decided success for this gear, which reduced the steam consumption to a very low figure, while the governing was brought to the high state of perfection which was necessary for cotton mill driving. The demand for higher steam pressures and powers led to the development of the compound engine, and in the year 1881 a 4000 horse-power engine of the cross-compound Corliss type was built for a boiler pressure of 100 lb. per square inch. The "life" of these Lancashire mill engines has not yet been determined, but it is interesting to note that this 4000 horse-power engine, after twenty-seven years' working, was fitted with a smaller high-pressure cylinder because the boiler pressure was raised to 150 lb. per square inch.

The next development in connection with cotton mill driving was the introduction of the rope drive to replace the old bevel gearing, and in this branch Hick, Hargreaves took a prominent part. Early in the present century the use of superheated steam led to the introduction of the drop valve engine and later the Uniflow engine, an interesting example of which is one of 1750 I.H.P. constructed in 1930. The gradual decline in the demand for slow-speed engines caused the firm to branch out into other fields of activity, and the most important of these is the introduction of the two-stage steam jet air ejector in 1916, when the manufacture of high vacuum condenser plants was begun. Since their first introduction Hick, Hargreaves and Co. have supplied some of the largest condensing plants in this country, the latest being the two 75,000-kW plants at Barking power station. Other manufactures in recent years have been evaporators, deaerators, feed heaters, rotary water strainers, steam turbines, and air compressing plant.

At the centenary dinner mentioned above Mr. W. D'Arcy Madden, M. Inst. C.E., presided, and in reply to the toast of "Hick, Hargreaves and Co., Ltd.," proposed by Mr. W. B. Woodhouse, past-president of the Institution of Electrical Engineers, said there was a general belief that the first rays of the sunrise of better times were becoming visible, and there was justification for returning confidence.

The first shipment of Saskatchewan salt, taken from the Simpson salt well, about 80 miles from Saskatoon, is, says *Canada*, ready for distribution. More than seven years ago a company drilled for oil and about two years ago secured a salt brine deposit. The brine is being vaporised into salt by the Simpson Oil Company. A well is being drilled about 1¼ miles east of the salt well, where it is hoped to tap gas, to be used at the salt well for vaporisation. The industry thus closely resembles that of Szechuan. With the profits from the salt the company will continue its search for oil in a field that geologists have said has good possibilities for the discovery of oil.

Commercial Motor Transport Exhibition.

No. II.

(*Continued from page* 430, *November 3rd.*)

HARDY MOTORS, LTD.

THE chief exhibit on the stand of Hardy Motors, Ltd., of Southall, and one of the most attractive in the Exhibition, is the railcar we described fully and illustrated two weeks ago. Since that occasion, however, more photographs of the vehicle have become available, and we reproduce herewith in Figs. 8 and 9, two interior views showing respectively the passengers' and driver's compartments. The former shows very well how much window space there is and how the seating accommodation is arranged. In the centre of the coach there is a wide vestibule with large swing doors for access and exit at platform level. In addition, as we mentioned in our previous article, a trap in the floor can be raised opposite these doors exposing steps to rail level. The illustration of the driver's compartment gives an excellent impression of the wide degree of visibility he enjoys. At a glance it might be thought that the controls are not arranged to the best advantage, for two of the levers appear to be set rather far from the seat. In fact, however, these two levers are just those which are most seldom used, the hand brake and the reversing lever. The former is more or less an emergency device, and is also used when the vehicle is to stand for long periods without the engine running. In normal running, the vacuum brake finger lever, which, in the engraving is hidden from view behind the seat, is used. As for the reversing lever, on entering the cab at the terminus to perform the return journey, the driver merely pushes it forward and subsequently never interferes with it until the journey is completed. As a matter of fact, the exaggerated perspective of the photograph gives a quite incorrect impression of the distance of the levers from the driver's hands, as we found for ourselves at the Exhibition by sitting in the driver's seat. The pedal to be seen in the engraving is the accelerator, and the gear selector lever of the Wilson gear-box is also just visible.

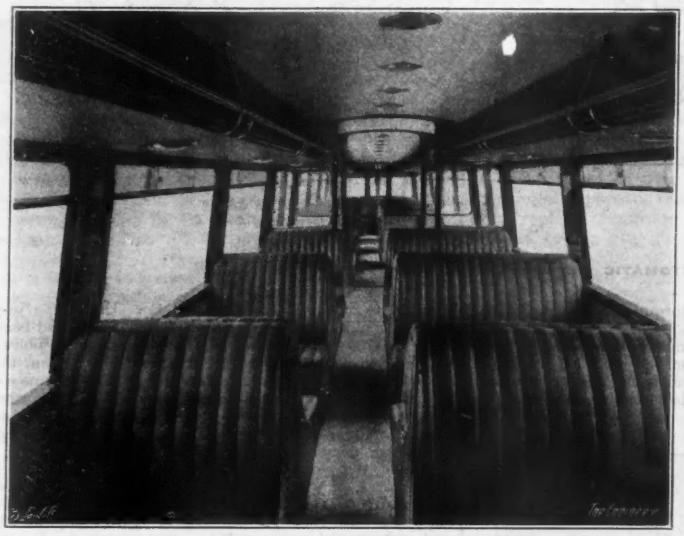


FIG. 8—INTERIOR OF 69-SEATER RAILCAR—HARDY

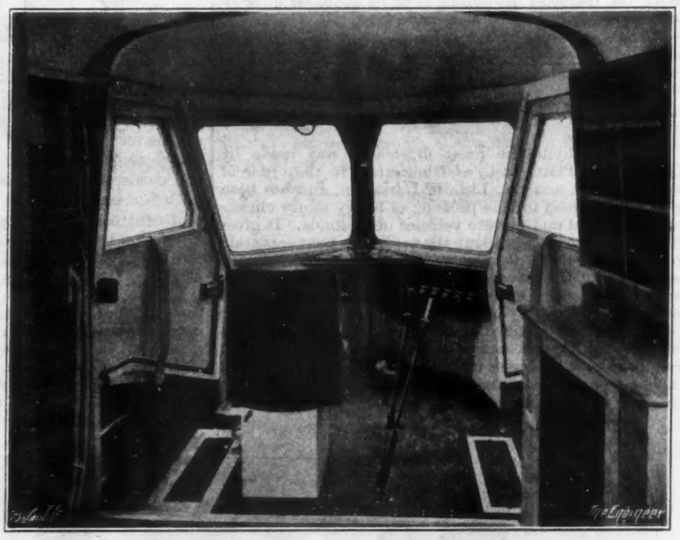


FIG. 9—DRIVER'S COMPARTMENT OF RAILCAR—HARDY

COMMER CARS, LTD.

Amongst the exhibits of Commer Cars, Ltd., of Luton, one of the newest productions, the "Pug" 2-tonner, by reason of some of the novel features in its design, deserves particular mention. It has been designed especially for the economical handling of loads in congested areas, and has the remarkably small turning circle of 33ft., although its overall length is 14ft. 7in. The wheel base, however, is only 8ft. As might, perhaps, be inferred from the engraving, Fig. 10, the engine is not situated in the position usual to forward control vehicles, but further back behind the driver. Being mounted, together with the clutch and gear-box, in a sub-frame, it can be dropped from the chassis quite easily by detaching four nuts and bolts, while the sub-frame itself is carried on a three-point rubber suspension. The power unit has four cylinders, and gives a maximum output of 44 H.P. If the position of the engine is unusual, so, too, is the arrangement of the controls. It has been realised that in a vehicle intended for local deliveries easy access to the cab is a matter of some importance. The controls are so arranged that there is nothing to inconvenience the driver or his mate in entering or leaving the cab from either side. For instance, the steering wheel is mounted on a horizontal steering column, while the brake and gear levers are placed centrally in the cab. It will also be noticed from the engraving that the floor of the cab is conveniently low.

One of the most interesting features on this stand is the entry of the oil engine into a small horse-power class, for a 2-ton "Centaur" drop-sided lorry, with a Perkins compression-ignition engine developing 45 B.H.P. is shown. Besides this particular chassis we understand that the 1½-ton "Raider" can also be supplied with an oil engine drive.

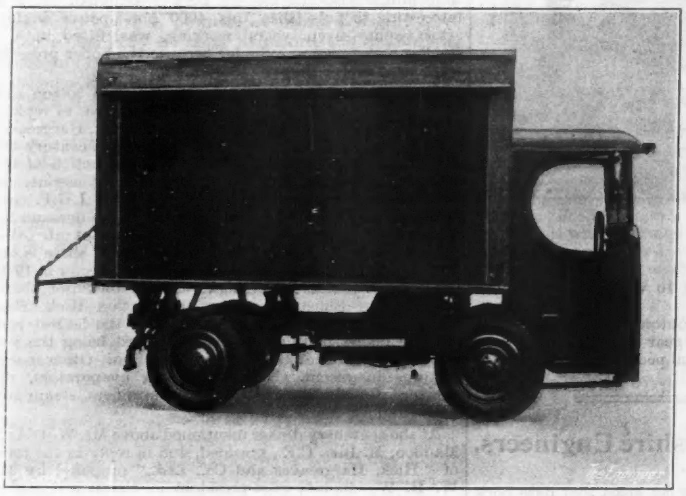


FIG. 10—THE "PUG" TWO-TONNER—COMMER

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LTD.

The system of wagon building developed by Sir W. G. Armstrong, Whitworth and Co., Ltd., of Newcastle-on-Tyne, takes on a particular interest as the result of recent legislation, which taxes lorries on tare weight and at a considerably increased rate. It is claimed that the "Ironclad" lightweight body can show a saving in weight over more conventional forms of about 20 to 25 per cent. A photograph reproduced in Fig. 11 gives a general impression of the method by which the body is constructed. The framework of the body is built up of high tensile pressed steel sections joined together by electric welding. The cross beams, which form the main members of the structure, are each pressed from one steel sheet, lightening holes being provided. Vertical compression members are welded into each cross beam between the upper and lower flanges immediately above the points where the cross beam rests upon the chassis, and the cross beams are joined together in the centre by means of pressed steel plates welded between the vertical webs of each alternate pair of cross beams. This construction braces the cross beams, and at the same time accommodates the unavoidable movements of the chassis. The cross beams are connected at their outer ends by one-piece steel side rails of angle section, to which they are welded. The side rails are so designed that the horizontal flange forms a protection for the top edge of the side sill. Support for the rear portion of the body overhanging the chassis is provided by pressed steel gussets welded to the rear cross beam, and to the rear rail, the latter being of similar section to the side rails to which it is welded at the rear corners. The bottom flanges of the cross beams are connected longitudinally by means of two flat steel strips welded to the cross beams immediately above the chassis members. The floor is of oak board, 1in. thick, bolted down to the cross beams, and the side rails are of ash inserted into the steel side rails and secured by bolts passing vertically through the ash packing and the top flange of the

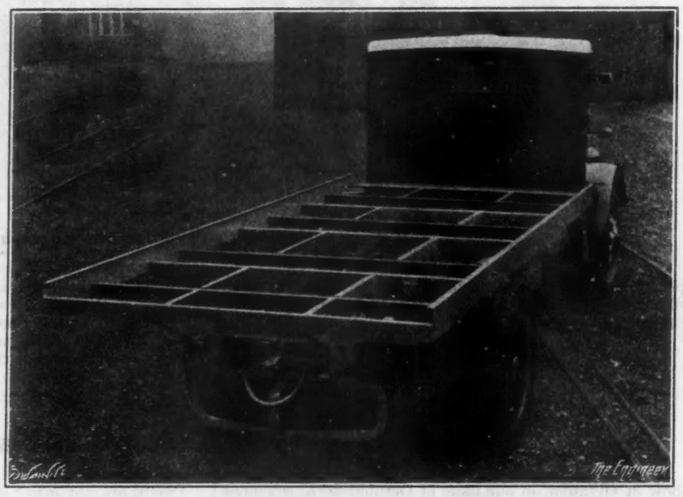


FIG. 11—"IRONCLAD" FRAMEWORK CONSTRUCTION—ARMSTRONG

steel side rail. Protection for the rear edge of the floor is provided by inserting the floor boards underneath the flange of the rear rail. Stout steel rope hooks are welded to the ends of the cross beams. The drop sides and taildoor each comprise first quality plywood panels, $\frac{7}{8}$in. thick, built into a light steel channel frame and stiffened with steel vertical battens, the whole of the steel framing being welded together after insertion of the plywood panels. This construction is applied also to trailers and examples are to be seen on the stand.

Crossley Motors, Ltd.

On the stand of Crossley Motors, Ltd., of Gorton, Manchester, there is a representative range of passenger and goods vehicles fitted with the Crossley heavy-oil engine and Crossley petrol motor. One of the larger exhibits is the double-deck chassis fitted with a "V R 6" six-cylinder Crossley oil engine, which, the makers claim, operates without smoke or odour. A side view of this engine is reproduced in Fig. 12, while in Fig. 13 we illustrate a rear view of a typical Crossley chassis.

The new designs of chassis include the "Beta" 4 to 5-ton vehicle, with a four-cylinder V R 4, 66 B.H.P. engine, and a 3 to 4-ton "Delta" vehicle, engined with a four-cylinder petrol motor. The four-cylinder oil engine is similar, except in the number of cylinders, to the six-cylinder unit we illustrate.

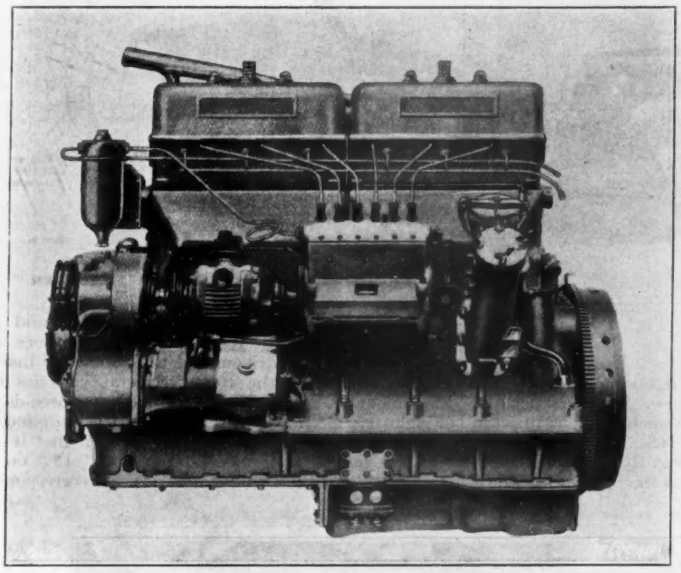


FIG. 12—100 B.H.P. "VR 6" OIL ENGINE—CROSSLEY

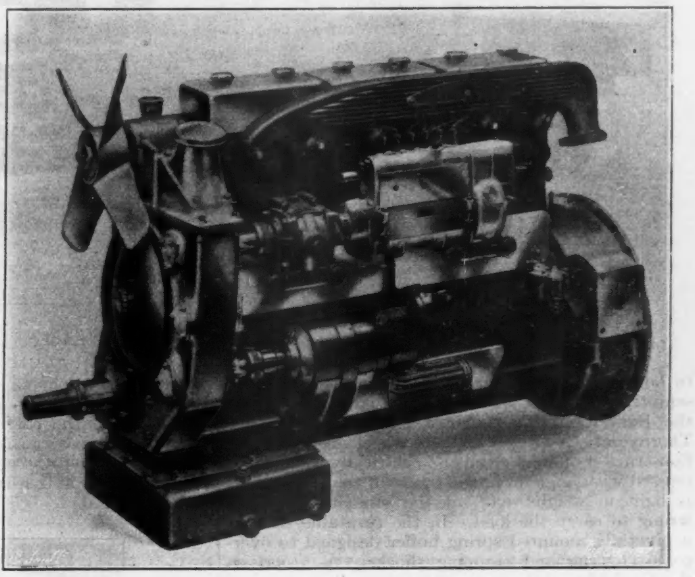


FIG 14—140 B.H.P. 6-CYLINDER OIL ENGINE—TANGYE

The V R 6 engine operates on the Crossley-Ricardo swirl chamber injection principle, and has a designed output of 62 B.H.P. at 1000 r.p.m., and 100 B.H.P. at 1700 r.p.m., with a cylinder bore of $4\frac{7}{16}$in. and a stroke of 6in. Its R.A.C. rating is 47·3 H.P., and its capacity is 556·7 cubic inches, or 9120 c.cm. All the auxiliary units are attached on the near side of the engine, the off side being reserved for the exhaust and inlet manifolds and the starting motor. As indicated in our illustration, Fig. 12, the cylinder heads are made in groups of three, and are bolted to a cast iron cylinder block which rests on the aluminium alloy crank case, this carrying in turn special cylinder liners made of close-grained air-hardened metal. Steel connecting-rods are employed with aluminium alloy pistons, and the crank shaft is fitted with a torsional oscillation damper. The engine is governed for maximum and minimum speeds, but is so arranged that the hand control is not effected within this range. The full load fuel consumption is about 0·47 lb. per B.H.P.-hour, and the average brake mean effective pressure is nearly 90 lb. per square inch. The economy and reliability of the Crossley oil engine in a large number of goods and passenger vehicles has led, we learn, to many conversions from petrol engine operation being made.

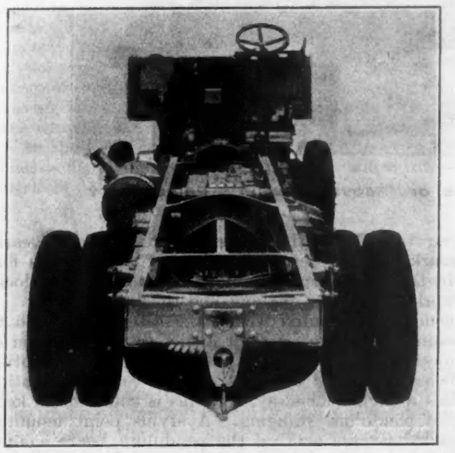


FIG 13—REAR VIEW OF "BETA" CHASSIS—CROSSLEY

Ransomes, Sims and Jefferies, Ltd.

Two electric trolley omnibuses of the latest design are shown by Ransomes, Sims and Jefferies, of Ipswich. One is a four-wheel, double-decker for the Ipswich Corporation, and the other a six-wheel, double-decker for Huddersfield. The chassis for the four-wheel vehicle, which is designed for regeneration, is shown in Fig. 15. The control gear is combined with the air-operated foot brakes, so that regenerative braking automatically takes place when the mechanical brakes are applied. In this way maximum regeneration is secured, resulting in reduced current consumption and increased life of the mechanical brake wearing parts. A small foot pedal resembling that of a petrol motor car serves for operating the controller. Of the twelve speeds obtainable eight are economical speeds which can be used without waste in resistances. Both vehicles are fitted with the makers' own traction compound-wound, enclosed ventilated motors, designed in accordance with the British Standard Specification and rated at 80 horse-power in each case. The ratio of horse-power to pounds weight is 1 : 11·2, which represents a considerable advance in this direction. It has been obtained by special attention to ventilation, the use of light-weight alloys, and by taking advantage of electric welding. Although the motor is placed under the saloon, and a short drive is thereby obtained, the height of the saloon from the ground is not increased.

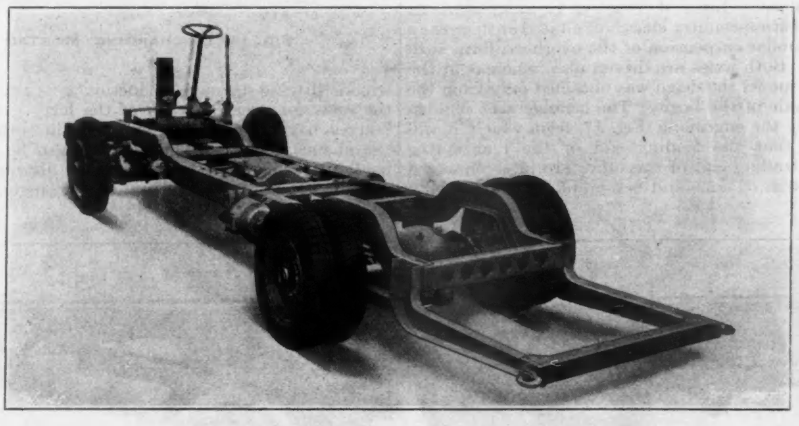


FIG. 15—FOUR-WHEEL REGENERATIVE TROLLEY BUS CHASSIS—RANSOMES, SIMS AND JEFFERIES

On both vehicles the transmission takes the form of a Ransomes-Garrett patented tubular telescopic propeller shaft and universal joint.

A noteworthy feature of the six-wheel vehicle is the provision of a third differential, which ensures that the drive on both rear axles is equalised at all times, irrespective of the tire diameters. Wheel slip is, therefore, eliminated and tire wear reduced.

As regards the design of the bogie, all torque rod reactions are neutralised, thereby counteracting the tendency for different pressures to occur on the two axles, during acceleration or braking. Another feature of the six-wheel vehicle is the patented cam brake gear, which ensures that the total braking area on all the brake drums is utilised when the service brake is brought into use. As compared with the service rendered by the orthodox system, this arrangement is said to have increased the life of the friction linings to a remarkable degree.

Another exhibit on Ransomes, Sims and Jefferies' stand is a new electric truck with a low-loading elevating platform. Simplicity is the outstanding feature of the design, and it is impossible for the platform to over-run in either direction. Damage to the mechanism is thus eliminated. Although the truck is designed to carry a load of 2 tons, it has a large reserve of power, and on test it took its full load up a gradient of 1 in 5.

Tangyes Ltd.

The firm of Tangyes Ltd., of Cornwall Works, Birmingham, is showing a full range of garage equipment and generating and power plant, including a 7-ton hydraulic lift for commercial vehicles. This is shown in operation with a Daimler commercial chassis equipped with a Tangye heavy oil engine. Both the four and the six-cylinder engines are also exhibited on the stand, and we have chosen the latter unit for illustration in Fig. 14. It operates on the "Omo" combustion principle, which, it may be recalled, incorporates a hot body with an oblique passage connecting to the cylinder space. A complete description of the combustion process, and typical performance results, were given in The Engineer of October 16th, 1931. The Tangye engine has been designed to conform with the best British commercial vehicle practice, and to give easy access to all working parts. As our illustration shows, the cylinder heads are cast in pairs. They are made of a special nickel iron, and are secured to an aluminium alloy cylinder block and crank case carrying the centrifugally cast cylinder liners in water jackets. The pistons are die cast and are of the Nelson-Bohnalite type, with four pressure rings and one oil scraper ring. The connecting-rods are of nickel steel with white metalled bottom ends, and a hardened and ground crank shaft is employed. The auxiliaries and lubricating arrangements conform to standard practice, special features being that the auxiliary drives are all enclosed and are mounted on the near side of the engine. The engine operates with a lubricating oil pressure of about 60 lb. per square inch.

The engine we have described has a designed output of 120 B.H.P. at 1800 r.p.m. and 140 maximum at 2000 r.p.m. Its capacity is 9·2 litres or 0·566 cubic inch, corresponding to a high output of 15·9 B.H.P. per litre. It weighs with the starter 1350 lb. and has an R.A.C. rating of 45·9 H.P. A feature is the low injection pressure of 1400 lb. per square inch, with an idling steady speed of 275 r.p.m. The fuel consumption is 0·4 to 0·45 lb. over a speed range from 1400 to 2000 r.p.m.

The Eagle Engineering Company, Ltd.

The new legislation for the regulation and taxation of heavy motor vehicles is bringing into greater prominence the possibilities of trailers and semi-trailers, and considerable interest, therefore, attaches to the stands of all the firms exhibiting such products. On the stand of the Eagle Engineering Company, Ltd., of Warwick, a wide range of such vehicles is to be seen, and we illustrate in Fig. 16 a 4/5-ton semi-trailer similar to the one actually shown. At the Exhibition this trailer is shown coupled to a Thornycroft A E/F B 4 12ft. wheel base chassis. Constructed of steel channels, electrically welded and trussed with angle iron, the frame of the attachment is light in weight, and, at the same time, amply strong to carry the load. In the turntable there is a pivotally mounted spring buffer designed to overcome starting and stopping shocks. As usual on these vehicles, there is a quick lifting device worked by means of curved racks and machine-cut pinions. Some of the most interesting trailers made by the firm are for use with the Scammell "Mechanical Horse." A special 6-ton hydraulic end-tip trailer of this type has a body of all-steel construction, 14ft. long by 7ft. wide by 1ft. 6in. deep, and the tipping gear is of the telescopic underslung ram type. The pump and tank units are mounted on the tractor. It is interesting to learn that the Eagle Engineering Company, Ltd., has come to a working agreement with Scammell Lorries, Ltd., to manufacture tipping trailers and municipal equipment for use in conjunction with the latter firm's mechanical horse.

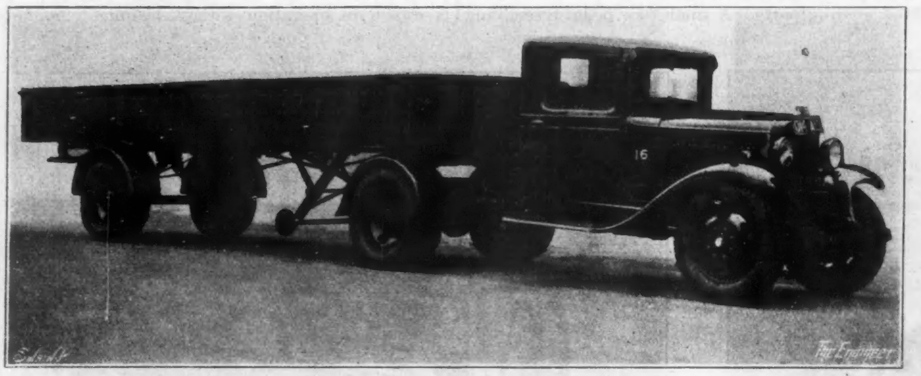


FIG. 16—4/5-TON SEMI-TRAILER—EAGLE

Garner Motors, Ltd.

In connection with the last biennial Commercial Motor Transport Exhibition we described and illustrated a method of underslung suspension for the two rear axles of a six-wheeled lorry devised by Garner Motors, Ltd., of Tyseley, Birmingham. In the 4 WD cross-country chassis exhibited at this year's show a similar suspension of the overhead form is to be seen. Both axles are driven also, whereas in the previous model the drive was obtained only from the leading axle of the bogie. The arrangement is illustrated by the engraving Fig. 17, from which it will be seen that the leading end of the rear spring and the trailing end of the other are interconnected by a system of links and bell-crank levers in such a way that the load is shared equally between the two wheels even on a very bumpy road. The drive and braking torque is taken by the springs. It should also be noticed that the axles are mounted offset on the springs in order that long easy riding springs may be fitted in spite of the short bogie centre distance. Other advantages of the arrangement are that the movement of the compensating mechanism for a given rise and fall is reduced, while the different periodicities of the two sides of each spring tend to prevent or damp out wheel bounce. In order to relieve the springs of the twisting strains caused by the large criss-cross articulation that may occur in cross-country work, swivelling spring eyes are introduced into the design at each end of each spring.

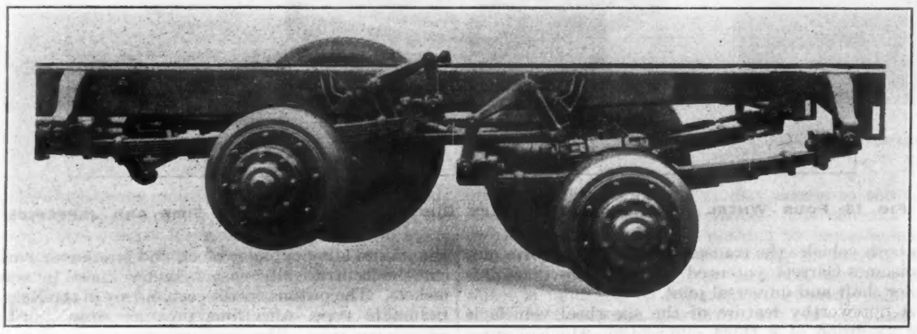


FIG. 17—OVERHEAD SUSPENSION SYSTEM FOR BOGIE OF SIX-WHEELER—GARNER

Several chassis and lorries of different types are shown by these makers, ranging from the 2½-ton 4 WD we have already mentioned to the TW 60 4-ton rigid six-wheeled forward control chassis.

Principality Wagon Company, Ltd.

On the stand of the Principality Wagon Company, Ltd., of Cardiff, a 5 cubic yard body, 13ft. by 6ft. by 2ft. 8in., is shown mounted in a "Thornycroft" J J chassis. The Principality body has a moving floor mounted upon rollers. The engraving reproduced in Fig. 18 shows the device in use. It is particularly adaptable for the carriage of such loads as mortar, road-making materials, coal, bricks, &c. In action, as will be seen from the engraving, the driver or one of the workmen winds a handle at the back of the body, which, driving through reduction gearing, delivers the material over the back of the lorry. Since the body is never tilted, no unequal strain is thrown on the chassis. The mechanism may also be used for loading. Where the haulage and distribution of road materials is concerned, the arrangement has the advantage that small dumps of road repair materials may be made at frequent intervals along the roadside with very little bother. The actual floor is made of rubber cotton duck belt, and the makers state that a case has been brought to their notice in which a Ford chassis had conveyed over 30,000 tons of coal with very little deterioration of the moving floor. Besides the Thornycroft chassis, the company is also exhibiting a 6-ton Eagle trailer equipped with the Principality flat-platform body, and another exhibit is an "either-side" discharge moving floor specialising in the conveyance of tarmacadam and road material in general.

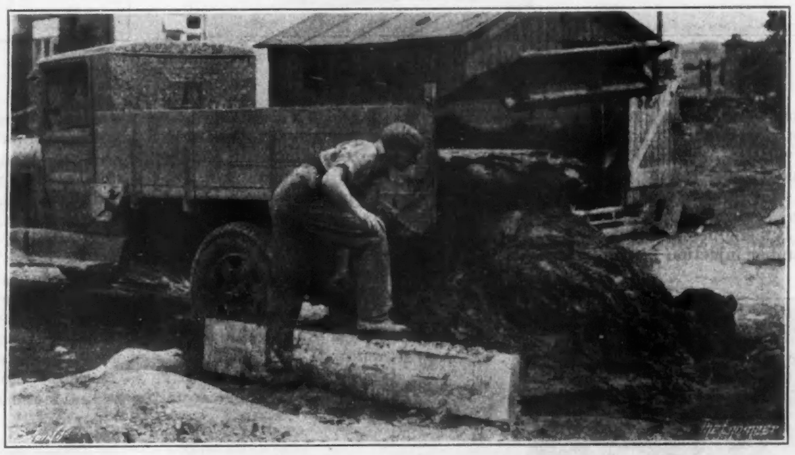
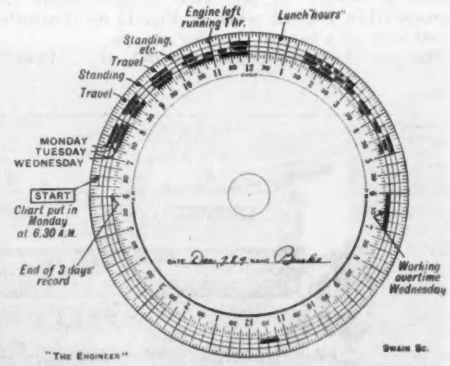


FIG. 18—DISCHARGING MORTAR BY MEANS OF "MOVING FLOOR"—PRINCIPALITY

Servis Recorders, Ltd.

Turning away for a while from actual vehicles and engines, we found on one of the stands in the gallery an ingenious and, at the same time, very simple instrument which automatically marks on a chart the exact time a vehicle is actually moving, the periods for which it is standing, and whether, in the latter condition, the engine is idling and shut off. The instrument is made by Servis Recorders, Ltd., of 72–75, Red Lion-street, London, and is particularly useful to road transport operators as a check upon their drivers and the actual use made of the vehicle on the road. Several varieties of instrument are made suitable for one-day, three-day, or eight-day charts. A three-day chart is reproduced in the drawing, Fig. 19. It will be seen that it is circular, and that 12 noon is placed at "12" on a clock face, and 12 midnight in a position corresponding to "6" with the intermediate times clearly marked. The actual diameter of the chart is 6in. In the instrument this chart is rotated by a clockwork mechanism making one revolution a day. A pendulum mounted within the case is arranged to swing in a plane at right angles to the direction of motion of the vehicle, its maximum degree of motion being controlled by stops. Every vehicle in motion has a slight side-sway, and this is sufficient to keep the pendulum swinging. A stylus point mounted on a suitable arm on the pendulum bears against the face of the chart, which, red in colour, is covered by a thin coating of wax. This wax is scraped off by the stylus, leaving the "red" of the chart face standing out in relief. Arrangements are made by a simple mechanism by which the stylus is caused to trace a spiral record on charts that last for more than one day. In the chart reproduced the times of running and standing are clearly marked. It will be observed that the driver never spent less than 1½ hours over his lunch, and that on Monday he finished his afternoon's work at 3 p.m., but did not come "home" till 5. On Wednesday, he worked overtime from 6 to 7 p.m., and for some reason the vehicle was used on Tuesday night. On Monday, between half-past ten and half-past eleven in the morning, the fact that the engine was left running although the vehicle was standing, is shown by a thickening of the line. This thickening of the line is caused by a slight "trembling" of the pendulum.



"THE ENGINEER" SWAIN Sc.

FIG. 19—CHART FROM SERVIS RECORDER

The working parts of the instrument are enclosed within a metal container about 7in. in diameter for the larger charts, such as that illustrated. This case is screwed on to the back of the cab above the driver's head. It is made in two halves hinged together with a "snap" lock opened by a key of the Yale type. The case is opened for the insertion of the chart and the winding of the clockwork motor every day, every third day, or every seventh day, according to the type of instrument installed.

THE A.E.C. AND ENGLISH ELECTRIC COMPANY, LTD.

In conjunction with the Associated Equipment Company, Ltd., the English Electric Company is showing the four-wheel double-deck trolley omnibus, illustrated in Fig. 20. It provides seating accommodation for sixty-three passengers, and is said to be the first vehicle of the kind to have such a carrying capacity. The body and equipment were made at the Preston and Bradford works of the latter firm, and the chassis at the Southall works of the A.E.C. The double-deck coach built body seats thirty passengers in the lower saloon and thirty-three in the upper compartment, the essential difference between this vehicle and other four-wheel double-deck vehicles being that the entrance is next to the driver and abreast of the front wheel. The rear part is entirely enclosed, and is utilised for seating accommodation. Apart from the fact that the arrangement provides nearly 20 per cent. increase in the number of seats, it simplifies the work of the driver and conductor. While the former has the exit and entrance of passengers directly under his observation, and is therefore able to start and stop the vehicle without having to wait for signals, the latter is able to devote the whole of his time to the collection of fares.

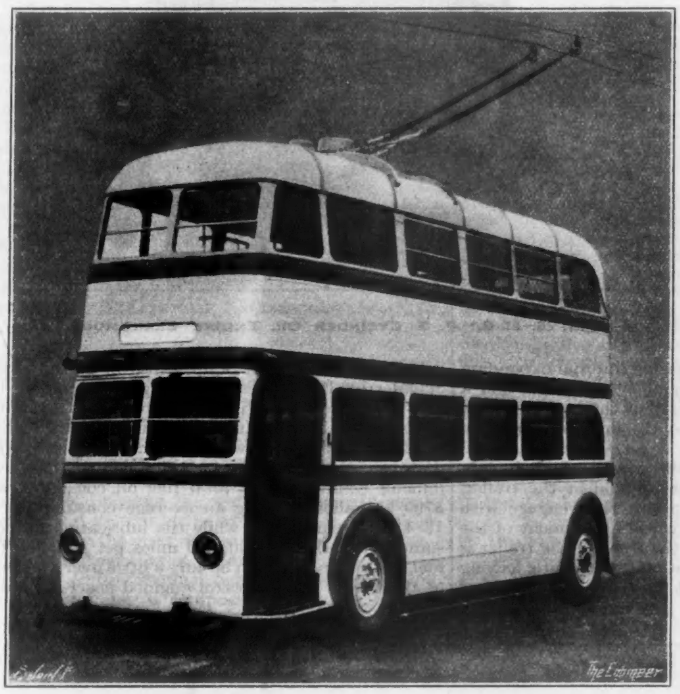


FIG. 20—DOUBLE-DECK TROLLEY BUS—A.E.C.-E.E.C.

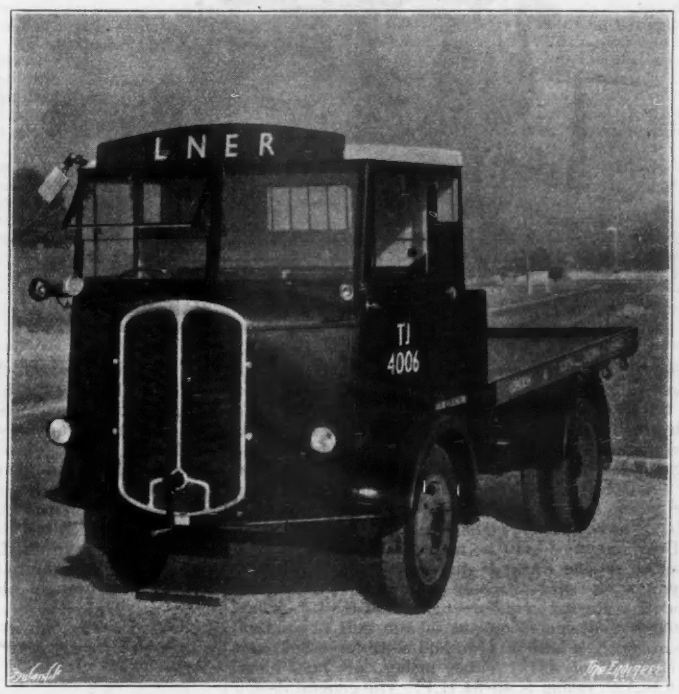


FIG. 22—2-TON HANDY PLATFORM LORRY—THORNYCROFT

As shown in the table of dimensions the two axle chassis has a wheel base of 15ft. 10in., and a turning circle of 54ft.

Chassis Dimensions.

Wheel base	15ft. 10in.
Wheel track, front	6ft. 4¾in.
rear	6ft. 6in.
Overall length	25ft. 8½in.
Overall width	7ft. 5½in.
Frame height, laden	1ft. 10in.
Turning circle	54ft.
Weight complete	3 tons 3 cwt.

Both front and rear wheels are fitted with 20in. by 11·25in. tires of the low-pressure balloon type. The frame is composed of 11in. by 3in. pressed channel section with the front end of the near side member downswept to facilitate low loading, while the cross members are of the tubular type.

Hydraulic shock absorbers are fitted to the springs, and interchangeable shackle pins are provided. The rear axle is of the fully floating variety. Chassis lubrication is reduced to a minimum by the use of roller bearings on the brake cam shafts and cross-shafts. Braking on all wheels is provided by the Lockheed air-assisted system, and is applied by means of a foot pedal. A 3/8 H.P. motor-driven compressor unit fixed to the side frame of the chassis by means of "Silentbloc" suspension, provides the compressed air. The hand brake operates independent shoes on the rear wheel. A spotlight at the rear of the vehicle is actuated automatically from the brake pedal.

All the electrical equipment is mounted on the frame, and the self-ventilated English Electric motor situated in the middle of the chassis and mounted cantilever fashion on the off side of the frame, drives the rear axle directly by means of a single cardan shaft fitted with large Spicer couplings. The arrangement greatly improves the accessibility of the motor, allows the provision of a low floor and assists weight distribution. Weatherproof and splashproof cases fixed to the chassis side frame house the contactors. Rustless and jointless unbreakable grid resistances are also mounted on the chassis framework from which they are well insulated.

The master controller, the reverser, trolley skate, change-over switch, terminal board, and stop light switch are mounted in a case under the driver's seat, and the controller is operated by means of an organ type foot pedal. Cab tire 660-volt sheathed cable is used throughout, and the body can be removed from the chassis while leaving all cables, with the exception of the trolley cabling, intact, the latter being disconnected at the terminal board. The entire equipment was tested at 3000 volts A.C. at the English Electric Company's works.

JOHN I. THORNYCROFT AND CO., LTD.

One of the largest exhibits on the stand of John I. Thornycroft, Ltd., of Basingstoke and London, is the new "Stag" 12-ton insulated box van, illustrated in Fig. 21, which is one of an order for forty similar vehicles recently placed with the firm by the Metropolitan Transport Supply Company. The engine is one of the Thornycroft six-cylinder 99 B.H.P. petrol models, with a bore of 4⅜in., a stroke of 5¼in., and an R.A.C. rating of 45·9 H.P. It operates in combination with a dry-plate clutch, and a four-speed gear-box, with an auxiliary gear-box operated by a separate lever and giving an additional range of exceptionally low gear ratios.

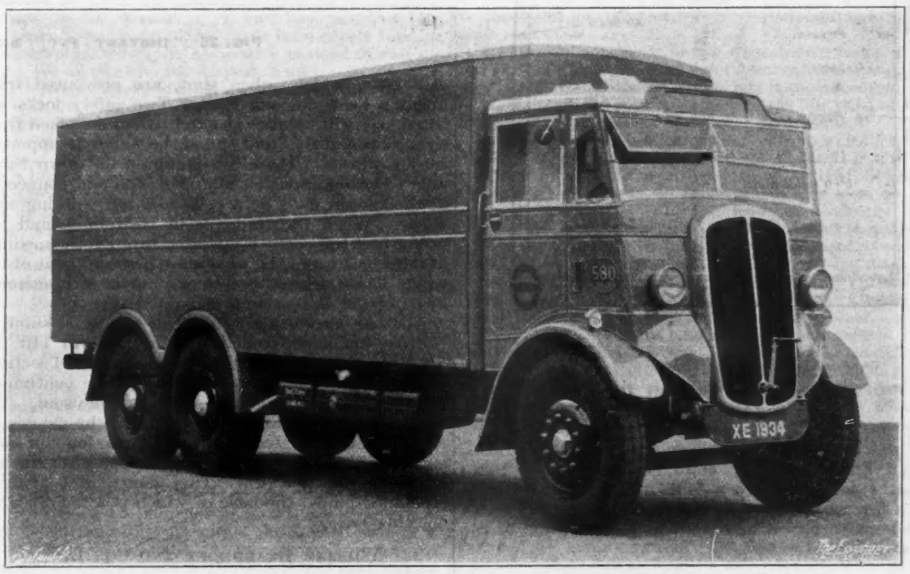


FIG. 21—"STAG" INSULATED 12-TON BOX VAN—THORNYCROFT

The main gear ratios are fourth, direct; third 1·52; second, 2·40; first, 4·50, and reverse, 5·50. The weight of the standard chassis with 42in. by 9in. straight-sided pneumatic tires on the front axle and 13·50in. by 20in. low-pressure pneumatic tires on the bogie axles, complete with auxiliaries, is 11,844 lb., which, together with a body allowance of 3700 lb., totals 15,544 lb. In Fig. 24 we show a section through the body of the van, giving the principal dimensions. Features in the design include the use of easily replaceable Masonite Tempered Preswood panels giving unusual strength for heavy service. In order to prevent the twisting of the body in service, a reinforcement of steel cross bracing has been employed, which gives a structure free from oscillation and body movement. There are two rear doors and a side door, and an important feature is the provision of air spaces in the sides and top of the body, with a view to equalising the temperature in the interior of the van in different weather conditions. By means of suitably arranged Beclawatt metal louvres at the top of the van and bottom openings, a free flow of air from bottom to top and from front to rear is obtained. The body is, as shown in the drawing, secured to the chassis by means of U bolts on stirrup brackets fitted to the cross bearers. The front end of the body is left clear of the chassis side members in order to allow for the flexing of the chassis. A particularly comfortable and neatly planned driver's cabin has been provided, with forward control and triple-servo brakes, acting on all six wheels.

Another interesting vehicle is the new "Handy" 2-ton platform lorry illustrated in Fig. 22, which is one of an order for thirty-one vehicles for the London and North-Eastern Railway. With a wheel base of only 9ft., the turning circle is approximately

37ft., while the unladen weight of the complete vehicle is only 2 tons 6 cwt. 1 qr. The power unit is a 40 B.H.P., four-cylinder type engine, with a 3¾in. bore and a 5in. stroke, and a Treasury rating of 22·5 H.P.; weight of chassis with cab, 1 ton 17 cwt., track 5ft. 7½in. There are forward controls and a forward engine mounting, and the rear axle is of the spiral bevel full-floating type, with a power-assisted foot brake acting on all four wheels. The tires are 32in. by 6in. truck pattern, with twin tires on the rear axle. A feature of the design is a driver's cab which, while providing a neat lay-out of controls and a single step, greatly assisting the ease of mounting and dismounting, can, by the removal of four bolts, be lifted from the vehicle in six minutes, leaving the engine and front axle ready for inspection. The cab can be replaced in eight minutes.

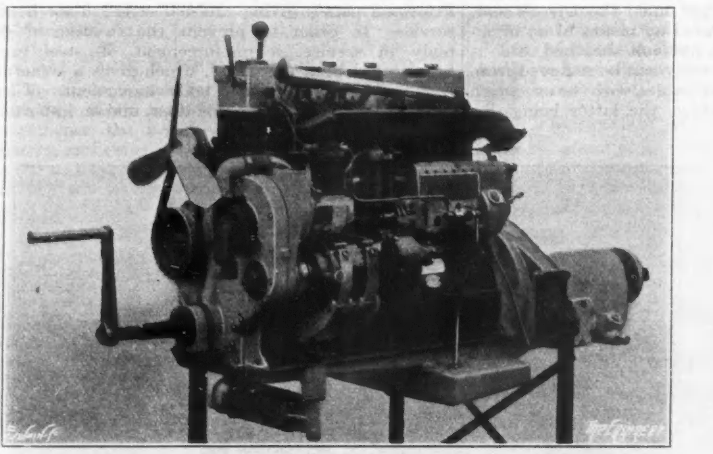


FIG. 23—100 B.H.P. 6-CYLINDER OIL ENGINE—THORNYCROFT

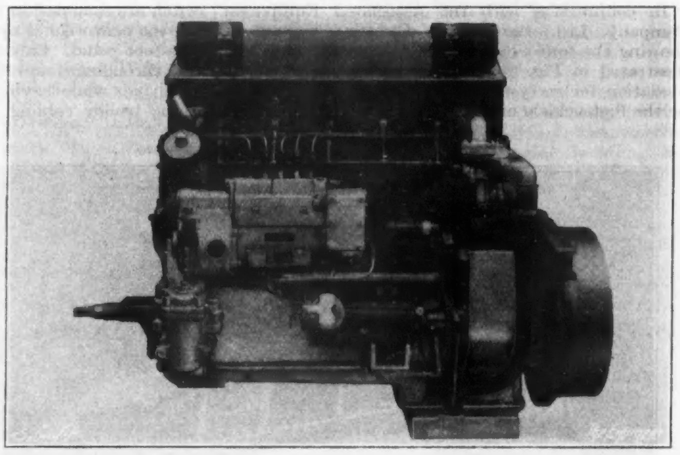


FIG. 26—85 B.H.P. 5-CYLINDER OIL ENGINE—BEARDMORE

Brief reference may be made to the new Thornycroft oil engine which is shown for the first time at Olympia in the form of six and four-cylinder models. The six-cylinder engine, illustrated in Fig. 23, has a designed output of 100 B.H.P. at 1800 r.p.m., with a bore of 4⅛in. and a stroke of 6in., and a capacity of 481·1 cubic inches, or 7880 c.cm. The R.A.C. rating is 40·84 H.P. The general design is very neat, and on the test bench at Basingstoke we were able to inspect the engine running under load very quietly and with a clear and odourless exhaust. As our illustration shows, it is complete with a unit construction gear-box, providing four forward speeds and one reverse, the top gear being the direct drive. Remote control change-speed gear is provided, the hand lever working in an oil-tight box bolted to the crank case of the engine. The gear ratios are: Fourth, direct; third, 1·52; second, 2·40; first, 4·48, and reverse, 5·48. When in the course of a few weeks the new engine has completed trials, we hope to give a more extended description of the new design.

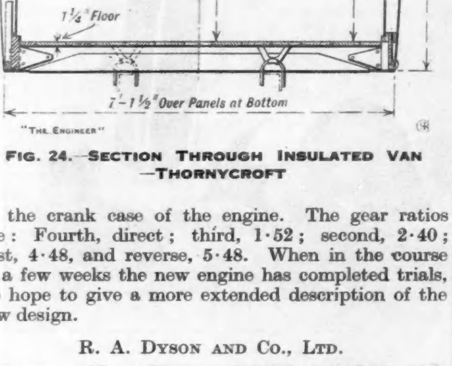


FIG. 24.—SECTION THROUGH INSULATED VAN —THORNYCROFT

R. A. DYSON AND CO., LTD.

The firm of R. A. Dyson and Co., Ltd., of Liverpool, is one of those which has early come to the conclusion that experimental work is necessary to see by how much the tare weight of its productions may be reduced, and we understand that the company is now busily engaged upon testing metals and forms of construction, which, though light, will give a generous overload safety factor. At the Exhibition the firm has concentrated upon the showing of popular types of trailer rather than those for special services, which are only of interest to the limited few faced by the particular problems concerned. One of the most interesting exhibits is the "Instant-Fit" six-wheeler attachment for 2-ton chassis. It is capable of carrying loads of 4 to 5 tons and is illustrated in Fig. 25. The chassis is built up of rolled steel channel sections, reinforced with flat mild steel strainers. The centre king posts, the bases of which are fitted in the centre cross member, are adjustable, and in this manner the slight initial stretch of the strainer bars can be taken up. Double-acting self-energising internal-expanding brakes in drums 16in. in diameter are fitted, and a feature of the arrangement is that the brake bracket and axle block are cast neatly integral with one another.

To attach the trailer to the power unit it is only necessary to back the latter up against the trailer. Lifting ramps on the power unit then engage with inclined guides on the fifth wheel attachment of the trailer, with the result that the front of the trailer is automatically lifted into position. Automatic locking in position is brought about by two hinged jaws of cast steel, which, when shut, are prevented from opening by a machined pin. Two safety locks are fitted. It will be observed that when detached from the power unit the front end of the trailer is supported by leg wheels. These are mounted on down tubes able to swing about their upper ends and connected at their lower ends by a yoke to a nut working on a screw. When the trailer is in position behind the power unit this screw is operated through the medium of mitre gears and the wheels are drawn up out of the way. These wheels are steerable, the arrangement being of the Ackerman centre point type.

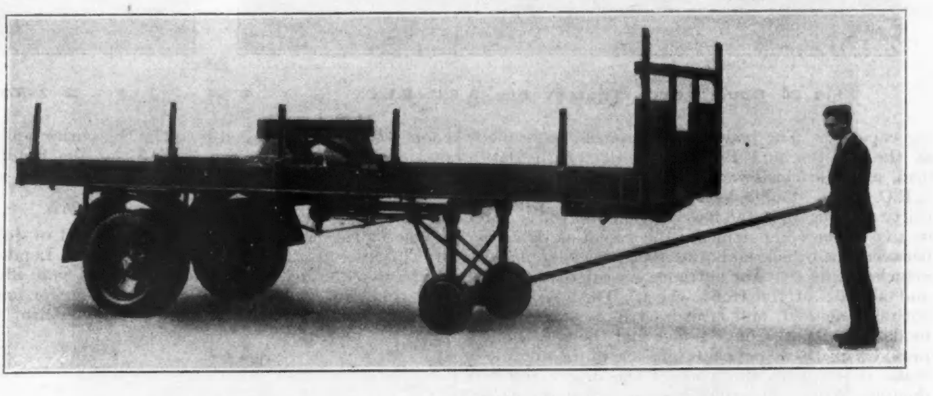


FIG. 25—"INSTANT-FIT" SIX-WHEELER ATTACHMENT—DYSON

Another interesting vehicle on the same stand is the 5–6-ton super-trailer, with a platform 14ft. by 7ft. It is constructed of rolled steel channel sections welded at the four corners to form one continuous frame. The suspension is somewhat unusual. The front end of each spring is secured to the chassis by means of a cast steel shoe. The rear end of each spring is also fitted with a shoe, the base of which is of a dovetail pattern. This shoe slides along a machined guide, the base of which is a reciprocal of the shoe base.

WILLIAM BEARDMORE AND CO., LTD.

A complete range of Beardmore high-speed heavy oil engines is displayed on the gallery stand of William Beardmore and Co., Ltd., of Dalmuir, and 36, Victoria-street, London. It includes four, five, and six-cylinder engines with a cylinder bore of 4¼in. and a stroke of 6in., giving at 2000 r.p.m. designed outputs of 65, 85, and 100 B.H.P. respectively. The weights of these engines, including the starter motor dynamo and brake exhauster, are 1160 lb., 1290 lb., and 1450 lb. for the three models in the order named above. In the accompanying illustration, Fig. 26, we show the five-cylinder model, which has an R.A.C. rating of 36·1 H.P. and is governed at 2250 r.p.m. It is a fly-wheel type unit arranged for hand starting. The performance results are illustrated in Fig. 27. In connection with the Olympia Show, Messrs. Beardmore have arranged to have available as demonstration vehicles several commercial vehicles which have been on the road for a considerable time. Among the vehicles available for demonstration purposes we may mention a large Albion vehicle and also Leyland vehicles, of which two examples may be given. A six-cylinder 100 B.H.P. Beardmore engine was installed in a 32-seater Leyland "Tiger" omnibus with a maximum designed speed of 50 miles per hour. Up till April a total of 50,796 miles was covered in 177 operating days, giving an average of 287 miles per day over difficult country. The total fuel oil consumed was 3790·75 gallons, giving an average consumption of 13·4 miles per gallon, while the lubricating oil consumption worked out at 650 miles per gallon. The fuel costs were shown to be only a little over a seventh of those of a similar petrol engined coach. Similar figures are available for a Leyland "Bull" forward-driven goods-carrying chassis which has now covered over 30,000 miles with an average consumption between 13 and 14 miles per gallon of oil fuel and a lubricating oil consumption of about 1000 miles per gallon.

Another interesting exhibit on the stand is a new 45 B.H.P. engine with a bore of 3½in. and a stroke of 5in., designed to operate at 2400 r.p.m., which will further extend the range of the Beardmore high-speed oil engine.

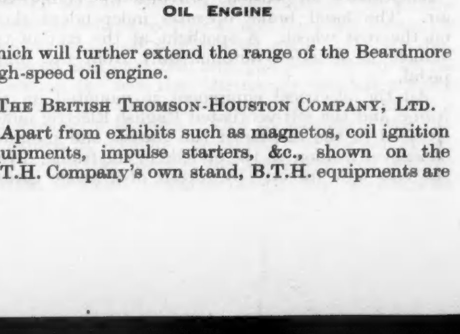


FIG. 27.—PERFORMANCE CURVES OF BEARDMORE OIL ENGINE

THE BRITISH THOMSON-HOUSTON COMPANY, LTD.

Apart from exhibits such as magnetos, coil ignition equipments, impulse starters, &c., shown on the B.T.H. Company's own stand, B.T.H. equipments are fitted to trolley omnibuses exhibited on other stands.

The contactor panels of these regenerative control equipments are mounted in the driver's cab. The shunt field contactors are fixed to the front dash, and as they open and close against rubber buffers they are practically noiseless. Simple control is made possible by a B.T.H. patented gearless controller, which requires a very light pressure to operate it. A short drive serves for transmitting the power to the back axle from the compact and lightweight motor, which is mounted under the floor of the vehicle, and is, therefore, very accessible. The shunt field resistance is composed of vitreous enamel tubes mounted on a frame with a louvred cover, whilst the main resistances, which are of the rustless unbreakable type, are mounted at the side of the chassis. While dirt and moisture cannot reach the resistances from below, a free passage is allowed from the front to ensure adequate ventilation. On a Karrier vehicle with B.T.H. field regulated equipment, the series field of the motor is divided into six stages by means of three contactors, which first close singly, then two simultaneously, and finally all together.

The master controller is fitted with a side-operated pedal with a patented internally expanding brake and a release spring, arranged so that when the driver tilts the pedal slightly backwards a locking action takes place, thus keeping the controller pedal steady in any desired position without effort, whilst the act of easing the foot pressure leaves the pedal free to return to the " off " position.

The Brush Electrical Engineering Company, Ltd.

A single-deck, long-distance, 32-seater coach, mounted on a Daimler chassis with a six-cylinder poppet valve engine and Daimler fluid fly-wheel transmission, incorporating a four-speed pre-selective self-changing gear-box, is shown by the Brush Electrical Engineering Company, Ltd., of Loughborough. The wheel base is 17ft. $\frac{3}{16}$in., the overall length 27ft. 1in., and the width 7ft. 6in. In regard to shape and contour at the front and rear, the vehicle is designed on the most modern lines, and incorporates such features as chariot pillars in the front, special belt rails, *de luxe* seating, lighting, and ventilation. The main framing is composed of selected oak and English ash, in combination with flitches and gussets to pillars, crossbars, and other members. The entrance is at the rear, where there is a sliding door, whilst an emergency exit with a hinged door is provided on the offside at the front. A hinged emergency light, with a sliding window, is provided on the near side of the driver's cab. The well type floor is covered with linoleum, whilst special rubber matting is used for the centre gangway. A single panel sliding " sunsallon " head is fitted to the roof, and is panelled on the undersides in Alhambrinal. Container racks inside the vehicle, and adjacent to the ceiling, lockers under the floors with doors to give access from the outside, and a boot built up as part of the roof outside at the rear, provide ample accommodation for luggage. Half drop windows of the Widney-Stuart latest type are fitted with louvres on the outside, whilst patented ventilators fitted with mirrors are provided at the front end.

The Brush Company is also exhibiting a double-deck, low-height, 56-seater, service omnibus body, mounted on a Leyland T D 3 chassis, equipped with a six-cylinder petrol engine, improved clutch, simplified brake gear, and a full floating axle.

(To be continued.)

Poplar is generally known as a perishable wood, difficult to dry; this is, in a sense, true. In the green condition poplar may easily become infected with fungi, with consequent rotting of the wood; this is particularly true of the sapwood. The exercise of certain precautions in the interval between the felling of the tree and the conversion of the log into lumber will prevent infection. By the observance of good drying practices the manufactured lumber may be seasoned without much loss through degrade caused by either rot or twisting and warping.

Speaking at the twelfth annual dinner of the Institution of Engineers (India), the Hon. M. E. A. H. Blunt said :—" My only venture in the engineering line has been the building of certain tanks. . . . They were very good tanks, and they held quite a lot of water, but unfortunately most of them also held a crocodile, which rather cramped the style of the villagers who wanted to use them. A real engineer, of course, would doubtless have devised some method for letting water in whilst keeping the crocodile out. This was beyond my engineering skill, but I rectified my error subsequently by shooting the crocodile. In addition to this solitary feat of mine, I can claim at the present moment to be very closely associated with one of our two great engineering departments, namely, irrigation. And I find that association as interesting as it is pleasant. Occasionally, too, it inspires me with awe, for instance, when I receive a report full of such terms as kilowatt, ampère, or volt. In such circumstances I have so far found the dictionary not particularly illuminating. So far as I can make out, the position is that when one Italian scientist called Volta carries one French scientist called Ampère against the resistance of one German scientist called Ohm, the result, more or less, is one English engineer called Watt. That, of course, is interesting knowledge, and I am pleased to possess it, but I have not yet discovered what use I can make of it."

Cast Iron Research Association.

On Wednesday, November 1st, Major F. A. Freeth, F.R.S., of Imperial Chemical Industries, took the chair at the annual luncheon of the Cast Iron Research Association, and delivered the short Presidential Address, from which the following passages have been taken :—

Unlike the great organisation with which my predecessor in office, Sir Harold Hartley, is connected, my company cannot claim to be a large producer of ferrous castings. It is, however, a very large user. Our needs cover a wide range of material and are met by a number of foundries. Since much of this material has to withstand special conditions with respect to corrosion, erosion, heat and mechanical stress, we look to the Cast Iron Research Association for the progress which makes possible the production of cast irons more capable of withstanding these conditions. We believe that it is the duty of all founders to support this Association, and hence put themselves in a position to carry out these developments as and when opportunity offers. We have made large-scale tests of some of the Association's developments, such as Silal and Nicrosilal heat-resisting irons, and we look forward to further opportunities of doing this as other discoveries are evolved. One of these is referred to in a guarded manner in the report, as in member's own interests I do not propose to particularise, but it offers promise of producing a standard type of cast iron which can act as a basis or datum for various methods which have been evolved for securing a high-quality material. These processes include desulphurisation, degasification, alloy additions of various kinds, together with the process of inoculation by means of which the 30-ton iron has now arrived at commercial production. This is a state of affairs upon which the industry and the Association can be warmly congratulated. As is hinted in the report, the process cannot yet be applied to the whole range of production, particularly to large castings, and in some castings of widely varying sections it may be undesirable to use it at all. While the designer endeavours to make the sections of any casting as uniform as possible, and to arrange changes in section to be as gradual as possible, the possibility of securing these different sections in one piece forms the very *raison d'être* of the casting itself.

You have doubtless all heard of the recent development which is being sponsored by my company, Imperial Chemical Industries, Ltd., for the production of oil from coal. The importance of this cannot be over-estimated, for the importation of foreign produced petrol is one of the most considerable individual factors in our adverse trade balance. The production of home-made petrol, practicable on account of our coal supplies, is not only of vast industrial importance, but it may be on occasion vital to our national security. We are making it our business to see that in the materials employed in the new plant, the fullest possible advantage is being taken of modern metallurgical knowledge.

I do not propose to say anything in detail about the work of the year because this is available in the annual report itself. I will content myself with observing that the Research Committee, in framing the programme, has had regard to every important aspect which enters into the production of the products with which you are concerned, and with adding that greater resources in equipment and staff would enable the programme to be both speeded up and extended.

I said on a previous occasion that the Association ought to have an induction melting furnace, even if it meant that the Council should go dog racing to raise the money ! It is not fitting that industry, which resignedly pays taxes and rates to put up the buildings and equipment for our universities and technical schools, should deny essentials to the body which is likely to have such a profound effect on its capacity to pay those rates and taxes in future. I learned, as I am sure you also learned, with particular pleasure of the generosity of our Vice-president. Mr. H. James Yates, in providing funds for a cupola furnace, an essential for which the Association has had to wait too long. We all owe him our deepest thanks.

My reference above to a datum reminds me that I must deal with the question of finance. The Cast Iron Research Association does not enjoy an overdraft at the bank. It is solvent, and all its equipment and apparatus, as you see from the balance sheets, stands at *nil* in the books. But it has no reserves and at any given time has less than a month's normal expenditure in hand. You are aware that up to June, 1931, ten years after our establishment, the work of the Association was made possible by a Government grant of £1 for £1 on industrial subscriptions. The Government has always insisted that Research Associations should be financed by means of regular subscriptions rather than by means of sporadic donations or payments for work actually done, because more than any other kind of human activity, research must be done steadily and without break in its continuity. This can only be provided on the subscription basis. It can, as I have indicated, be greatly assisted by appropriate apparatus and equipment and suitable accommodation and working conditions, but it depends primarily on the functioning of the grey matter in the mind of the investigator, and if the work is to be done properly he has to be protected reasonably from interruption. Now we have never in the Cast Iron Research Association considered direct contact with members in the industry as an interruption in this sense. The programme is designed to meet what the Council believes to be the needs of the industry, and the contact between the staff and members is a perpetual source of fresh inspiration as to what these needs are, apart from the opportunities it offers of applying what has already been learnt. This apart, I repeat that the investigator works most fruitfully when he works under the best conditions.

I have been engaged the whole of my working life in research, often research of a very abstract character, and from my later experience in encouraging and inspiring researchers. I want to tell you how very sympathetic we have to be towards them. I know no job which holds so many disappointments and discouragements. The business man, whether he be engaged in selling, in manufacture, or in purchasing, has his disappointments, but he stands on reasonably firm ground. He knows where he is. In pushing out, however, into the unknown, the research man is faced with a succession of disappointments ; just as walking may be described as a succession of interrupted falls, so research progress must largely consist in properly learning from failure. The process is almost impossible to describe, and, incidentally, almost equally impossible to organise. The investigator is so often dealing with the intangible. When a research problem can be reduced to the point at which a perfectly clear and definite programme can be laid down to a given end, the problem as such has practically ceased to exist. It has, in a sense, been solved because the path has been visualised, and all that remains is to proceed to the more or less anticipated conclusion. Before this, however, we have to go through a process which can only be described as getting a " hunch " or idea ; an experiment is tried to see if the idea works, and, if so, how far ; generally it does not ; sometimes it does, but not quite in the way it was expected. The idea has to be modified and a fresh experiment tried, and so the process goes on until a reasonably clear conception of what is happening in a given set of circumstances is evolved. When this conception has been fully formulated, it is necessary to try further experiments to see now whether the idea will work exactly as anticipated, in which case the conception stands verified. During the year the following up of one such train of thought in the laboratories involved two members of the staff in something like 900 individual melts of material. I want to lay stress on the necessity for persistence in reaching the conclusion, in spite of the discouragements that may have been felt, say, at melt No. 200 or melt No. 500.

Research is essentially exploration, for which the investigator has to fashion his own specially sensitive and delicate mental instruments. It is like trying to reach the centre of a maze, which can sometimes be found by a happy accident, or by sheer good luck, like drawing a horse in the Irish sweep, none the less welcome because it is so thoroughly deserved, but it is most assured when the side tracks which so often appear to be the main path are systematically explored and labelled for future use so as to prevent confusion. It is sometimes like trying to unravel a particularly tangled thread. You try to release a knot here and fail and you have to go to another and try that, and suddenly, after many efforts, the whole thing unravels almost miraculously if you have resisted the temptation to cut what may appear to be a loss.

The next difficulty occurs in putting the idea into practice, and cases are well known in which this industrial development has taken many years. Twenty or thirty years is by no means uncommon, and when the Association's heat-resisting irons were evolved one member ruefully remarked that they had only just settled down to manufacture on the basis of a discovery that was at that date over twenty years old. One of the great advantages of the research association movement has been to diminish this period, in which years have been reduced to months. The development stage, however, equally provides its problems no less difficult in their way than the original research and involving both expenditure and time. The troubles here arise from four main causes. The first is the larger scale on which the work is done ; the margins which suffice for laboratory work have to be increased in an ordinary production process for it to be mistake-proof. The mere change in scale also introduces complications. Secondly, the requirements of an individual works are in many respects peculiar to itself and the original process requires to be modified to suit. Thirdly, on the laboratory scale, for the purpose of making progress at all, it is necessary to simplify the procedure as much as possible. In work on an industrial scale, and particularly in this extremely complex material, many variables come in which have not been allowed for in the original work, and which change from application to application, and these have to be taken into account. Finally, there are the differences in the capacity of various works, which show themselves, for example, in the fact that one works can undertake a development and carry it through quite successfully, whereas another works meets with difficulties, either of *personnel* or of equipment or control. There may be successful manufacture but inadequate selling, or *vice versâ*, and so on.

A successful conclusion at this stage demonstrates what was once said by a very successful American scientist, that the " equilibrium between mental and material conception is so sensitive that anything which to the fair mind seems possible is to the trained persistence permissible."

Reverting to the question of finance, from which I have digressed, the Association enjoyed the £1 for £1 grant for the last few years of the ten-year period, to 1931, because the Council undertook, in times which now seem to us relatively prosperous, to raise from the industry for succeeding years an income of £10,000 in order to qualify for a grant of £5000. Had the money been raised, it could have been very well expended, but the depression made it impossible and we are indebted to the Advisory Council for their consideration in modifying the arrangement into which the Council in all good faith had entered. The necessity for economy, furthermore, compelled the Government to reduce the grant offered from the maximum of £5000 to a maximum of £3000. During 1931–32 and 1932–33 this grant was earned by raising from the industry the stipulated amounts, respectively £6250 and £6500. The two years' breathing space expired last June, at the beginning of this financial year, but even at this date the possibility of raising the datum of £5000 plus £3000 in order to earn £3000 in grant is beyond immediate possibility, and the Advisory Council has for the current year and next year fixed the datum at £4000, so that the Association must raise £7000 in the current year and next year to earn £3000 of grant. For every £1 short of that sum £1 of grant will be lost. I understand that the estimated income for the current year is of the order of £6700, and we therefore are anxious to make this £7000, so that the programme can be maintained. In the hope and anticipation that this will be done, the Council has decided not to curtail the present programme and we look to the industry to make up the amount required. If we can get more, we shall have a good case for asking that the grant maximum be increased, and we shall not be content until our present income is doubled. We all owe our warmest thanks to the Advisory Council and the Department of Scientific and Industrial Research for their consideration and help throughout.

One of my predecessors, Sir Philip Nash, in 1929 quoted an estimate from the annual report that year of the value of the output of this industry considered as castings, the figure being one approaching 40 millions sterling per annum in a normal year. Since this estimate was formulated the Census of Production figures for 1930 have been published and the output figure for the industry is given, incidentally for the first time, as nearly 26 millions. Bearing in mind the fact that the Census admittedly does not include all establishments, and also the difference between 1930 and a normal year, the estimate is very satisfactory. There is no estimate for the corresponding Census in 1924 for foundries, but the figures exist for the iron and steel trades as a whole and assuming that the drop in output is similar in the two cases, in 1924 the value may be taken as 37·5 millions, without taking any account of those establishments not covered by the Census. I think you will agree that the estimate is very close indeed. I believe that an industry whose products are valued at figures of this order both requires and is able adequately to support a national research organisation such as we represent.

I wish to say a word with reference to the success recently of the latest attempt we have made to increase the area of contact between the staff and the members. This was the study course held in October. The numbers greatly exceeded anticipations, and I have had an opportunity of reading a number of letters from members who were represented, expressing their satisfaction with the course in the most enthusiastic terms and making it clear beyond any doubt that similar provision in future at appropriate intervals would be welcomed. The preparation for this course entailed a large amount of work from the staff and the results greatly exceeded expectations.

I would conclude by saying that Sir Harold Hartley's period of office has ended on a note which must give you all satisfaction. The financial difficulties caused by the fall in grant will, during the coming year, I think, be entirely overcome, and with the grant situation stabilised for two years we can look forward to a period of uninterrupted progress. Anything I and your Council can do to promote that will be done.

South African Engineering Notes.

(By our South African Correspondent.)

Industrial Output.

According to Union statistics, the value of the industrial output in 1929–30 was £113,000,000, as compared with £45,500,000 obtained from the gold mines. The industries paid wages amounting to £27,500,000, as against £14,943,000 paid out by the mines. The industries bought £27,000,000 of South African goods, as compared with £9,600,000 worth bought by the gold mines. In making comparisons between the mining activities of the Union and those of the other industries—"secondary" industries—it has to be borne in mind though that it is the mining industry that has brought the population to the country that has, in turn, brought these industries into being. Some interesting facts have just been obtained with regard to the industrial expansion during the last four years, which are also very surprising in view of the fact that the period referred to has been one of serious depression; 23,602 more people, including 12,352 Europeans, are now employed in South Africa as the result of 557 new factories having been set in operation in the last four years, and the erection of more factories is contemplated. The South African factories are paying out £4,457,621 more in wages than four years ago, and South African industrial concerns—excluding the mines—are now spending £8,179,696 more in purchasing raw materials, and the value of the goods turned out is no less than £17,996,830 more. Modern methods are employed in all factories of repute, and expense is not spared in installing the latest machinery. Workmanship has been improving year by year, as experience has been gained. Of course, as the figures show, many of the new factories are small and only deserve the name of factory because of the definition of factory in the Acts. Among new factories which are either in course of construction or shortly to be proceeded with are the following:—A match factory at Germiston, a welding electrode plant at Durban, an oil seed crushing plant in Johannesburg, a knitted underwear manufactory at Johannesburg, and a large grape juice factory near Cape Town. There are to be three new footwear factories. Barkers (Britain) are to make men's footwear at Cape Town, and two big factories are to manufacture canvas shoes. One of these is to turn out 2,000,000 pairs per annum. Large capital is being invested in a factory to make champagne at Paarl. A big Netherlands firm has decided to make worsted and clothing materials in Johannesburg; another manufacturer is to make helmets there, and yet another a silk-finishing factory. On the Umgeni River, near Durban, a paper-making industry is to be established. The factory is to cost £300,000, and will produce a minimum of 15,000 tons of paper from 45,000 tons of "bagasse"—a waste residue of the cane after sucrose extraction is complete.

Johannesburg's Traffic System.

According to a resolution passed by the Johannesburg City Council, London's traffic chief (Lord Ashfield) will appoint an oversea expert to act as chairman of the Commission of Inquiry into the city's transport system. The University of Witwatersrand and the Electricity Supply Commission have been asked to appoint the other members. Elaborate figures have been prepared to show Lord Ashfield how Johannesburg's transport system works. It has been a formidable task for the administrative staff. It is intended to show what system is in force in a city of 205,400 Europeans where each individual takes an average of 449·57 rides a year, and the tram routes cover 51 miles and the omnibuses 38·6 miles. The statement shows that the capital expenditure on the trams is £1,412,268, and on the omnibuses £128,783. Almost 1000 men are employed by the Department, and the wage paid is about £250,000 a year for the uniformed staff alone. During 1932 the Council ran a fleet of 210 trams and 56 omnibuses. The joint loss of the trams and omnibuses for the year ended June 30th, 1933, it is estimated, will be £79,000. These particulars are supplied to Lord Ashfield to enable him to arrive at a decision as to the type of man required to act as chairman of the Commission.

Faster Mailboat Service.

A mild agitation is proceeding in favour of obtaining a faster mail service. At present the Union-Castle liners carrying the mail between London and South African ports take sixteen days and twelve hours. To reduce this time by one day, as suggested, would mean, if the sailing times were retained as at present, that the mailboat would arrive at Cape Town on a Sunday, a difficult day for working and involving the incurring of heavy overtime charges. If this was avoided by starting the voyages earlier, there would still remain the extra expenditure on coal. To reduce the time by one day would mean an increase in speed of 1 knot. In the case of mailboats such as the "Arundel" and "Windsor Castle," this would mean an additional consumption of coal of 1100 tons on the outward voyage, and a corresponding amount on the homeward voyage, or 2200 tons more. It is also pointed out that the earnings obtained by the company from the East and West Coasts will now be greatly reduced by the subsidy now agreed to be given to foreign lines to run steamships to serve those coasts already well served by the existing British and foreign lines. It is true that the speed of the mailboats under the present contracts is little greater than thirty years ago, but there is no real demand for quicker passages, either on the part of the passengers or exporters, except, perhaps, in the case of shipments of fruit to England. All things considered it does not seem that the shipping company can be reasonably asked for additional services, or for a reduction in freight charges and passenger fares, as is also suggested, unless, of course, the Union Government is prepared to increase the subsidy. As the Government has decided to give £150,000 a year to Italian lines for almost nothing, it should be able to offer the Union-Castle Company a liberal increase for the additional speed mentioned.

Goods Traffic Jump.

Goods traffic earnings on the railways reached the highest figures for any one week during the past 2½ years in the week ended September 16th. The total earnings during the week were approximately £80,000 better than the total for the corresponding week of 1932. During the week ended September 23rd, both Cape Town and Durban harbours broke all weekly tonnage records for the past three years. Over 35,700 tons of cargo were landed at Durban and over 30,000 tons at Cape Town. With the object of increasing trade with the East, the Union Government has appointed a Trade Commissioner, who will be stationed at Batavia.

Wages in Gold Industry.

The great increase in the profits of the gold mines, consequent on the big rise in the price of gold since the Union went off the gold standard, which has resulted in the gold mines making a profit for the first nine months of 1933 of £22,549,236, compared with £10,889,736 for the corresponding period in 1932, has resulted in the miners putting in a demand for a share in the excess profits. The men's unions have just put forward a request for a 20 per cent. advance in wages, and for a working week of forty hours instead of forty-eight, as at present. The Chamber of Mines is considering the demands. Some concessions will probably be made.

The Analysis of Coal and Coke.

A Fuel Research Survey paper, No. 29, by Dr. H. V. A. Briscoe, Dr. J. H. Jones, and Dr. C. B. Marson (deceased), dealing with an investigation into the accuracy of routine analytical determinations on coal and coke, has just been published by the Department of Scientific and Industrial Research.* Most of the results were obtained from investigations carried out jointly at Newcastle-upon-Tyne by the staff of the Department's Coal Survey Laboratory and the staff of the Northern Coke Research Committee. The paper points out that accuracy in sampling and in analysing coal and coke is of very great importance, although, from the nature of the substances dealt with, it is very difficult of attainment. The question is by no means of academic interest only. Coal is a highly complex substance, which, in chemical and physical characteristics, ranges through almost endless variety. This is now recognised in industry, where modern conditions and processes demand a high efficiency, only to be achieved, in the case of coal, by careful selection of the coal used. For this reason, the classification of coal, originally an academic investigation, is now of considerable interest to industrialists. This classification, however, is almost wholly based on chemical data, and the question of the reliability of the data becomes important.

Further, it is now generally recognised that the only satisfactory basis on which coal can be bought and sold is partly its chemical constitution, and, more especially, its heat-giving power, as determined in the laboratory. In the case of metallurgical coke, on which the iron and steel industry depends, the requirements of the consumer are equally explicit, although tending more to the physical nature of the material than to its chemical composition.

The reliance to be placed on the data obtained in the laboratory depends to a larger degree, however, on the accuracy of sampling. When it is realised that the sampling of coal and coke is in itself a very difficult question, it will be seen that the whole problem moves in a vicious circle, for we can only judge the accuracy of sampling by comparing results of chemical analysis, and our judgment of the accuracy of chemical analysis is dependent on the degree of accuracy in sampling.

The present paper forms an important contribution to this subject, for, in the work which it describes, the accuracy of the analytical results alone, free from the complication of sampling, has been considered on a mathematical basis, with the result that it is now possible to judge the accuracy of routine analytical work, and, in addition, to obtain a clearer view of other aspects of the problem, viz., sampling and the actual methods used in analysis.

In the work on coal, sampling errors were reduced to a minimum. A single block, about 16 lb. weight, was crushed, mixed and divided by coning and quartering into sixty-four small samples. These were subjected to routine laboratory determination. The results were then tabulated and examined in the light of the mathematical principle known as the Law of Errors. The mathematical formulæ used are given and the results obtained are tabulated in detail at the end of the report.

Routine determinations on coke were dealt with in a similar way, one representative sample being divided into sixty-four laboratory samples on which repeat determinations were carried out.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

ROAD TRAFFIC SIGNALS.

505—1933. The Departmental Committee on Traffic Signs, which was appointed by the Minister of Transport in December, 1931, requested the British Standards Institution this year to make recommendations for a standard form of specification for the equipment of light signals and to consider the following matters:—(1) The laying down of standards including standards of colour with which optical systems of signals should comply; (2) the specification of the type of beam to be employed; (3) how far it was practical and desirable to require that all types of flexible progressive installations should be capable of being interconnected. The British Standards Institution has accordingly drawn up this specification. It first of all defines the terms used, *e.g.*, signal, signal head assembly, &c., and then, under the heading "Optical Requirements," deals with the distribution of light, the direction of the beam, the arrangement of the optical systems, the green arrow, the colorimetric properties and the transmittance of the glass, the visor, and the height of the signal. The actual construction of the signal, the control requirements, such as the time of the cycle, and the sequence and duration of the aspects, the master, local and isolated controllers, and the control construction are dealt with in separate sections and there is a miscellaneous section covering such items as elimination of surges in the co-ordinating circuit, radio interference, external finish, interconnecting cables, and the use of plant leased from the G.P.O. The last section deals with the tests necessary for compliance with the specification. One of the seven appendices indicates a type of apparatus which may be used for preventing electrical interference with radio transmissions caused by the operation of the signals.

CATALOGUES.

Siemens Bros. and Co., Ltd., Woolwich, S.E.18.—Catalogue 150 on paper-insulated cables.

Gummers, Ltd., Rotherham.—Catalogue section "E" of the "Twintite" plunger valve.

Rose, Downs and Thompson, Ltd., Old Foundry, Hull.—List 15 on vegetable oil refining plant.

Davy Bros., Ltd., Park Ironworks, Sheffield.—Publication 63 on filter presses, dryers, and mixers.

Thos. Firth and John Brown, Ltd., Sheffield.—A publication on steels specially resistant to corrosion.

Elliott Bros. (London), Ltd., Century Works, Lewisham, S.E.13.—Publication 811 on the "Tolemache" bin level indicator.

Imports Duties Advisory Committee.—The Import Duties Advisory Committee gives notice of an application for a redution in the import duty on magnet coils wound with aluminium wire adapted for use in electric hoists and separators.

London Iron and Steel Exchange.—The annual dinner of the London Iron and Steel Exchange will be held on January 30th at Claridge's Hotel, Brook-street, W.1. Colonel D. J. Colville, Minister for the Department of Overseas Trade, has accepted an invitation to attend. A number of persons prominent in the iron and steel trades will also be present.

Lantern Slides.—Edward Bennis and Co., Ltd., desire us to say that they have a large number of lantern slides dealing with mechanical stokers and mechanical coal and ash-handling plant, which they will be pleased to lend to societies, institutions or individuals for lecture purposes. Particulars of these are given in a printed booklet which will be sent free to any of our readers on request.

Engineers' German Circle.—There was a good attendance at the Institution of Mechanical Engineers on Monday evening, November 6th, for the second paper of the session, which was read by Mr. F. W. Fass, of the Friedrich Krupp Grusonwerk A.G., of Magdeburg-Buckau, who took as his subject "New Developments in the Design of Cold Rolling Mills, with Special Reference to the Manufacture of Tin Strip." The paper was illustrated with lantern slides. In introducing his subject, Mr. Fass stated that there had been a recent welcome increase in the German tin-plate industry, and he illustrated his paper with descriptions of typical American and German hot and cold rolling mills for mild steel strip. The installations dealt with included typical hot strip rolling plants and Steckel cold rolling mills, with descaling and coiling machines. Some of the more recent developments in rolling mill design were then dealt with in detail and a description was finally given of the modern annealing methods. Typical lay-outs for a modern plant for the annual production of 50 to 70,000 tons of tin strip were shown, with alternative arrangements of four-high rolling mills and Steckel mills, while a particularly interesting mill was a 59in. wide four-high mill with a patented feeding machine for the production of steel sheets for motor vehicle bodies. A short discussion followed the paper, and after the meeting members adjourned to the Anglo-German Club for supper.

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* Published by H.M. Stationery Office, 9d. net.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Pig Iron Market.

The market for pig iron in this country is strengthening, and one of the features of the position is that buyers who placed contracts some weeks ago for forward delivery up to the end of the year are now showing a disposition to buy for delivery in the spring and are also increasing the quantities they are taking against their old contracts. The general demand has improved, and business with those consumers who as a rule buy from hand to mouth is developing along satisfactory lines. The position on the North-East Coast is especially sound. Scottish consumers, as well as local buyers, are taking good quantities, and although no official figures have been issued regarding the tonnage now in stock in makers' hands, assertions have been made for some time past that these are not greatly in excess of the normal, allowing for the fact that considerable quantities have already been sold. At the same time, the market would feel happier if an authoritative statement on the position were made. The position in the Midland pig iron market has also become more satisfactory, and although in some quarters it was expected that the Midland producers would raise their prices, at the last meeting their decision to maintain existing rates did not come as a surprise, as in this part of the country stocks have not been depleted to the same extent as those on the North-East Coast. The demand from the light castings trade is active, particularly from that section engaged in producing building material, whilst business in forge iron has also increased during the past few weeks. In Lancashire the demand for pig iron is steadily expanding, although the rate at which consumers are taking deliveries might be improved upon. The condition of the engineering trades in this district is better than for some time, and if this improvement continues there should be a substantial increase in the supplies required. The situation in Scotland is not perhaps so satisfactory as in most of the English districts, and probably the demand is not sufficient to take care of the full production. The hematite market shows a notable change for the better lately. The recent increase in prices has been maintained and good quantities have been sold in the Midlands and South Wales. The export market remains uncontrolled and makers appear anxious to secure business, and seem prepared to accept cheap prices, probably with a view to reducing their stocks, which are still considerable.

Semi-finished Steel.

The cheerful conditions which have prevailed in this market for some time past continue to rule, and, if anything, the situation is improving from the point of view of the producers. The minimum price for British billets has been definitely fixed at £5 5s., although, in fact, this figure had been in operation for several weeks. It is difficult, however, to buy at less than £5 7s. 6d., or to place orders for delivery before the end of this year. For forward sales probably the minimum quotation would be accepted, but there are a number of re-rollers who, for various reasons, find it necessary to place comparatively small orders for near delivery. Naturally, consumers are becoming rather perturbed at the manner in which the market is gaining strength. A number of the more important users have long period arrangements with the producing works, and may not be immediately affected by the position. Others, however, are nervous, not only concerning the tightness of the position, but also regarding the prospects of further increases in price. Under these conditions more business than usual has been placed with Continental makers, although for some time only moderate quantities have been offered on the British market. In particular the tonnage of small billets offered to British consumers has been declining for some time. The advance in prices of British semi-finished steel has been followed by an increase of 2s. 6d. (gold) in the Continental prices, making the basis price for billets, 2in. and up, £5 10s. d/d Birmingham, and £5 d/d other districts, whilst the quotation for sheet bars is now £5. So complete is the Continental control of the importation of billets and sheet bars into the British market under the new Cartel arrangements that it will probably be found that as the British price is advanced so the Continental quotation will be fixed immediately below it. The quotations for British soft, medium, and hard basic billets have been advanced 5s.

Shipbuilding and Current Business.

The new shipbuilding orders which have reached the Scottish and English shipyards, although they do not amount to a revival in this depressed industry, are encouraging, as they indicate that shipping firms are taking a more optimistic view of the position. On the Clyde a contract for a motor liner of 10,500 tons gross and a cargo steamer of 5000 tons d.w. have been placed with Alexander Stephen and Sons, Ltd., of Linthouse. D. and W. Henderson and Co., Ltd., of Partick, have secured an order for a cargo steamer of 5000 tons d.w., and another cargo steamer of similar tonnage has been ordered from Lithgows, Ltd., of Port Glasgow. J. and G. Kincaid and Co., Ltd., of Greenock, are to provide two sets of oil engines for the motor vessel to be built by Alexander Stephen and Sons. At Leith the construction of a twin vessel will immediately follow the launching of a large motor coaster. It is also announced that Vickers-Armstrong, Ltd., have received inquiries for two refrigerator cargo ships. Interest has been aroused by a statement that agents for the Soviet Government are inspecting the British cargo vessels which have been offered for sale, with the intention of acquiring several of them. In South Wales, although no contracts of importance have been announced, the ship-repairing yards have been busy. Business has been active along the Welsh coast, including the yards at Cardiff, Newport, Barry, Penarth, and Swansea. The Department of Overseas Trade announces that the following contracts are open for tender:—Brazil: Viacao Ferrea do Rio Grande do Sul, hinges, steel brushes, to be presented in Rio Grande do Sul by December 14th; South African Railways and Harbours, wrought iron short link chain, $\frac{1}{4}$in. to $1\frac{1}{2}$in. diameter, stud link cable with shackes for mooring, short link chain electrically welded or machine-made quality, for the period from July 1st, 1934, to June 30th, 1935, to be presented in Johannesburg by December 18th; also supplies of bar steel, to be presented by December 4th; Australia, Victorian Government Railways Commissioners, supply and delivery of one set feed-water heater and equipment for application to an A 2 locomotive, to be presented in Melbourne by January 10th, 1934; Posts and Telegraphs Department, supplies of lead-covered telephone cables, to be presented in Melbourne by November 21st.

Scotland, Lancashire, and Yorkshire.

The new shipbuilding orders for the Clyde which were announced last week have created a more cheerful tone in this market, and backed up by an active demand for steel for ship-repairing should improve the position of the Scottish steel works. The general demand for steel materials is on a good scale, although the engineering industry in Scotland has not been well occupied of late. Business in plates seems to have increased slightly, but there is a considerable amount of unemployed plant in this department. The Scottish sheet makers are only moderately employed, and the galvanised section of the trade, in common with the English works, is experiencing a poor demand. The Scottish re-rollers are better off for work than they have been of late, but are losing a considerable amount of business through the competition of English and Continental works. The quotation for re-rolled steel bars is held at £7 5s. d/d, whilst for export the figure is £6 10s. to £6 15s. Active conditions rule in the Lancashire market, and some fair-sized engineering contracts have been booked which will require a good tonnage of steel. Skipworth, Jones and Lomax, Ltd., of Manchester, have secured an order for steelwork for a new bridge for the Salford Corporation, whilst the Blackpool Municipality has ordered a large gasholder from R. and J. Dempster, Ltd., of Elland. Orders for paper-making machinery have also been secured by Chas. Walmsley and Co., Ltd., of Bury. The increase in the price of billets, and the strong demand for small bars, has led to the Lancashire re-rollers advancing their prices to £7 10s., but it remains to be seen if the re-rollers in other districts will follow their example. If not, it seems possible that competition from sources outside the district will develop. In Yorkshire there has been a continued improvement in business in iron and steel materials, the demand for rods for reinforced concrete work being particularly active. Consumers also continue to take good quantities of special and stainless steel, particularly stainless steel sheets. Business in plates in this district, as in other parts of England, has been light for some time, but recently there has been rather more movement in this department.

Ferro-alloys.

Business in the ferro-alloy market has been slightly better during the past week or two; but still leaves a great deal to be desired. Consumers of nearly all ferro-alloys are content to buy on a hand-to-mouth scale, and transactions of importance are rare. The market for tungsten provides an exception to this generalisation. The price of this alloy continues to advance, owing to the Chinese suppliers of wolfram ore resolutely withholding supplies. Whether the Chinese are deliberately engineering a corner, or whether the scarcity is due to the unsettled conditions in China, it is difficult to say, but the general impression is that the Chinese dealers are clever enough to see the possibilities of the situation, and to keep a tight hold on the quantities which come into their hands. A certain amount of ore is coming from other parts of the world, but it is not sufficient to make up for the absence of the normal supplies from the Far East, and the prices for ferro-tungsten and tungsten metal powder have advanced by 6d. per lb. All sales of this alloy are for prompt delivery, as forward business for the time being is out of the question. The demand for ferro-chrome is steady, and prices show a strong tendency to advance. There has been little speculation in the market, and buying has been almost entirely for industrial purposes. The possibility of a rise in the price of ferro-silicon has created some interest in that market, but the amount of buying has not been sufficient to affect the position. Quotations are still £12 10s. for 45 to 50 per cent. and £18 2s. 6d. for 75 per cent. Business in ferro-vanadium has become more active, and the overseas demand has increased. Interest in ferro-manganese also appears to be growing, and there has been a good inquiry of late on export account. Few transactions are reported in ferro-phosphorus, and the quotation is unchanged at £14 10s. On the other hand, the demand for nickel has broadened considerably, and an extensive business has been done with Germany. The price remains unchanged at £230.

Finished Iron.

Progress in the finished iron market is much slower than in many other departments of the iron and steel trades. In the Midlands business, whilst on a rather broader basis than immediately after the holidays, does not increase according to expectations. Usually at this time of the year a brisk demand is experienced by the producers of bar iron; but at present, although the demand for high-class bars is fairly good, the call for Crown bars is not maintained at the rate which characterised the industry in the early part of September. Business in common bar iron also is quiet, and the producers complain of the competition they are experiencing from the cheaper steel bars. Quotations vary considerably and Crown bars are quoted at £8 10s. to £9 10s. Steady conditions rule in the Lancashire bar iron trade, and prices remain unaltered at £9 10s, with Crown bars quoted at £9. The Scottish producers are handicapped by the small weights of the orders they receive.

Copper and Tin.

The prevailing tendency in all the metal markets this week has been for prices to sink to a lower level, owing to the absence of support from consumers. This is particularly noticeable in electrolytic copper. The American producers do not appear to be able to reach agreement with the Customs smelters upon the provisions of the copper "code" and in spite of the currency inflation American users have bought only moderate quantities. As a consequence, whilst American domestic prices were retained at 8 c., the export price dropped back to 7.85 c., which, as the exchange varied, moved between £35 10s. and £36. This week a fair business was transacted. Owing to the instability of the exchange, the American producers have on several occasions quoted in sterling. The world's markets, however, are too much under the influence of the confusion resulting from the latest American monetary policy to provide an outlet for substantial quantities of copper, and so far as the copper market is concerned, the efforts of the American administration to force up prices have had the opposite effect by destroying business confidence. It is reported that the American producers have asked the American Government to purchase 100,000 tons of their stocks, but this seems an unlikely procedure, even for the present American Administration. . . . Tin has been the steadiest of the non-ferrous metals, and it is one in which American purchasers have shown a fair amount of interest. On the other hand, buying by British and Continental consumers has not improved, and so far as the latter are concerned the quantities have been insignificant. The October statistics showed a net reduction in the visible supply of 2050 tons, after allowing for an increase of 680 tons in the carry-over at the Arnheim smelter. American purchases, plus the improvement in the statistical position, have aroused a certain amount of fresh interest in this market, although speculation is not on the scale which might have been expected. The tendency of dealers in this market is to watch events, although the undertone is sound and any decline in prices has been quickly recovered.

Lead and Spelter.

Prices in the lead market have fluctuated within a few shillings. The declaration of 2000 tons of Mexican lead on the market had a somewhat depressing influence towards the end of last week. This lead being foreign metal is subject to a duty, and will therefore go direct into bonded warehouse, where it will remain until it can be shipped to an overseas destination. In the meantime those to whom it was tendered against Metal Exchange contracts were not anxious to take it up, so it was lent forward on a contango of about 7s. 6d. The question is often asked why this foreign lead should be sent to the London market, but so long as the London Metal Exchange is the one market in which the metal can always be sold, foreign lead will be sent here from time to time. In other respects the market has been in a sound position. The sharp advance which followed the decline in prices was due to reports of industrial troubles at the Australian mines, and was not altogether maintained. . . . Dull conditions have ruled in the spelter market, and even the news that the Cartel contemplated reducing output to 45 per cent. and tightening up its regulations against overproduction had little effect upon the position. Declarations of November spelter have resulted in an increase in the contango, but the worst feature of the position is that the industrial demand for the metal seems to have declined. The galvanising industry has been taking small quantities for some weeks, and although it is said that the brass manufacturers have been rather busier of late, this has not been sufficient to create an appearance of activity in the spelter market.

Average Metal Quotations.

The London Metal Exchange official average quotations for October show a decline for the third month in succession, excepting in the case of tin, which registered an increase in the average price for cash tin of £6 11s. 4d. and for three months of £6 10s. 7d. Apart from this the difference between the September and October averages was not large. The average price for cash copper was down by £1 9s. 9d., and of three months by £1 10s. 1d.; whilst the electrolytic copper price was £1 6s. 10d. less than in September. The average lead price showed a variation of only 2s. 7d. for all positions, which is a sufficient indication of the steadiness of the market. In spelter also the movement was comparatively narrow. For shipment in the current month the average quotation for October was 10s. down, whilst for shipment in the third month following it was 8s. 11d. lower, the mean price being 9s. 5d. less than in September. The official average quotations are as follows:—

STANDARD COPPER	Cash	£33	13	$10\frac{31}{44}$
	3 Months	£33	17	$2\frac{41}{44}$
	Settlement	£33	14	$1\frac{1}{11}$
ELECTROLYTIC COPPER		£37	7	$0\frac{6}{11}$
ELECTROLYTIC WIRE BARS		£37	14	$6\frac{6}{11}$
BEST SELECTED COPPER		£36	6	$4\frac{2}{3}$
STANDARD TIN	Cash	£223	10	$7\frac{1}{2}$
	3 Months	£223	8	$11\frac{1}{22}$
	Settlement	£223	10	$10\frac{10}{11}$
LEAD	For shipment the current month	£11	16	$0\frac{21}{22}$
	For shipment the third following month	£12	2	$0\frac{6}{11}$
	Mean	£11	19	$0\frac{3}{4}$
	Settlement	£11	16	$5\frac{8}{11}$
SPELTER	For shipment the current month	£16	6	$2\frac{7}{22}$
	For shipment the third following month	£16	11	$11\frac{19}{22}$
	Mean	£16	9	$1\frac{1}{11}$
	Settlement	£16	6	3

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— *(D/d Teesside Area)*		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	2 17 6	—
Midlands—		
Staffs.— *(Delivered to Black Country Station)*		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 2 6	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	2 19 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ $\frac{5}{16}$in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ $\frac{3}{16}$in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in.	8 15 0	7 15 0
„ $\frac{5}{16}$in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ $\frac{3}{16}$in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0 to 7 0 0	6 15 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ $\frac{5}{16}$in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ $\frac{3}{16}$in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL *(continued)*

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ $\frac{5}{16}$in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ $\frac{3}{16}$in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	6 15 0	6 5 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ $\frac{5}{16}$in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ $\frac{3}{16}$in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0
Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 5 0	7 15 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ $\frac{5}{16}$in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ $\frac{3}{16}$in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 17/– to 17/3.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 7 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£22 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, November 8th.

Copper—		
Cash	£31 17 6 to £31 18 9	
Three months	£32 0 0 to £32 1 3	
Electrolytic	£35 0 0 to £36 0 0	
Best Selected Ingots, d/d Birmingham	£35 5 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£32 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£226 15 0 to £226 17 6	
Three months	£226 5 0 to £226 7 6	
Lead:	£11 17 6 to £12 2 6	
Spelter:	£15 15 0 to £15 18 9	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 13/–
„ Glasgow— Ell	12/6 to 14/9
„ „ Splint	14/9 to 15/–
Ayrshire—	
(f.o.b. Ports)—Steam	12/– to 12/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/– to 13/6
Unscreened Navigation	12/3 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/– to 13/6
Secondary Steam	13/–

ENGLAND.

	Inland.	Export.
Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/6 to 20/6
Furnace Coke		13/– to 17/6
Northumberland—		
Blyth Best		13/9 to 14/–
„ Second		12/9 to 13/–
„ Steam		10/–
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/6
Foundry Coke		17/– to 18/6
Sheffield—		
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	6/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	19/– to 36/–
Furnace Coke	16/– to 17/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	10/– to 11/–
Steam Coals:	
Large	18/– to 20/6
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3¼d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Monsieur Paul Painleve.

One of the eminent mathematicians of his day, Monsieur Paul Painlevé, who died of heart failure in Paris on Sunday of last week, at the age of seventy years, endowed engineering with mathematical discoveries of value. His interest in mechanics and invention did much to encourage initiative in the ministerial offices he occupied from the time he entered public life. Obtaining a professorship of mathematics at Lille University at the age of twenty-three years, Monsieur Painlevé was appointed Lecturer at the Sorbonne four years later, and was finally Professor at the Ecole Polytechnique. He had already acquired a wide reputation for his works on differential equations. When Wilbur Wright made his experimental flights in France, Monsieur Painlevé was the first to be taken up in a plane as a passenger, and thenceforth he devoted much of his time to aviation and contributed largely to its scientific progress. So convinced was he of the possibilities of aviation that in 1910 he prepared for parliamentary groups in the Chamber of Deputies a full report upon its value for civil purposes and for national defence, and presented a plan of organisation. After the war he was for some time Minister of Air. For his services to science and to the State Monsieur Painlevé was buried with national honours.

Federation of European Engineers.

The National Syndicate of Fascist Engineers has sent invitations to engineering institutions in Europe to appoint representatives to attend a meeting at Rome at the end of this month or the beginning of December to discuss arrangements for the formation of a Federation of European Engineers. Contrary to the similar French proposal, which leaves the final constitution of the Federation to be settled by a Congress representing national groups, the Italians have presented a definite scheme that provides for a Federation of engineers holding first-class degrees, with the reservation that membership may be extended eventually to all persons of scientific and technical attainments. In a word, it appears that the idea is to create an international association, with the engineering profession as a nucleus, for an examination of economic and technical questions affecting capital and labour and social life generally.

Shipbuilding.

The outlook for shipbuilding has been somewhat improved by the distribution of orders under the programme of naval construction, and by the prospect of shipping companies adapting their fleets to more severe conditions of competition. The Messageries Maritimes are sending one of their most successful ships in the Mediterranean service to the Ciotat yard, where it will be lengthened forward by 8·5 m. on lines designed to increase the speed, and the propelling machinery will also be modified. This work will occupy about a year, and if the result is satisfactory, another ship running between France and Egypt will undergo a similar transformation. It is notworthy that the tonnage of ships laid up in French ports was reduced by 94,000 tons during the six weeks ending October 15th, the total at that date being 846,233 tons. No final decision has been come to yet respecting the claim of the insurance companies to recondition the "Atlantique" in a British yard, and the Compagnie Sud-Atlantique is reported to be taking proceedings against them to recover the full amount, while its intention to have a similar ship built in a French yard suggests the anticipation of a verdict of the arbitration court in its favour.

Coal.

The colliery interests are not relinquishing their efforts to induce the Government to adopt the fullest measure of protection for the coal industry. They affirm that the situation is going from bad to worse, and that notwithstanding the approach of winter there is increasing unemployment amongst miners and that about two-thirds of the men work less than forty hours a week. Stocks at the pits are said to be growing larger every month. The Miners' Union and the coalowners are both urging that the quotas of coal imports should be strictly adhered to, and that they should not be supplemented by special licences, as is sometimes the case, for example, with consignments through Atlantic ports. The arrangement entered into by the State for the importation of German coal by way of the Rhine for the benefit of the inland port of Strasbourg encourages this traffic. The mines in the Saar, worked by the State, are in competition with the northern collieries. They are, of course, within the French Customs frontier. French coalowners complain more particularly of the subsidies paid on the export of coal from Germany and Poland. The Belgian Government has imposed a tax of 10 per cent. on imported coal, the product of that tax to be distributed amongst Belgian coalowners as compensation for loss of trade and as a means of enabling them to keep up miners' wages. German importers refuse to pay the tax. In France, the difficulty is that the home collieries produce only about 75 per cent. of the normal consumption, and any excessive protection would inevitably put up the price of coal, which industrial consumers would not tolerate at a time when everything must be done to stem rising costs.

The Dunkirk Lock-out.

For more than a month operations at the port of Dunkirk have been practically suspended by a lock-out of dockers who refuse to work extra time for urgent loading and unloading of ships, and thereby leave the port in an unfavourable situation with respect to other ports where the same disabilities do not exist. This labour trouble has been causing auxiety to harbour authorities for some years past, and as there is no doubt about the character of the dockers' organisation, the authorities feel that they must put an end to a state of things which has been diverting traffic to Antwerp and other foreign ports.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

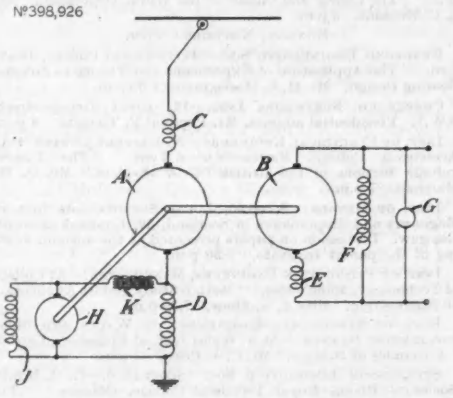
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

398,926. April 4th, 1932.—Electric Motor Control, Arnold Tustin, of 22, Glentilt-road, Sheffield, and Associated Electrical Industries, Ltd., of Crown House, Aldwych, Westminster.

The object of this invention is to provide improved arrangements for exciting the field of an electric motor so as to obtain approximate constancy of speed when the load on the motor varies and/or when the line voltage varies. A is the armature of the motor and B is the armature of a generator, which is mechanically coupled to the motor. The latter is provided with two series field windings, designated respectively C and D, while the generator is provided with a series field winding E and a shunt field winding F. The motor generator set, thus constituted, may form, for instance, part of the equipment of an electric traction system, the motor of the set being connected by means of a trolley between a line conductor and an earth conductor, and the generator supplying current to a load G connected across the generator terminals. The series field winding D of the motor is connected in circuit with the armature H of an exciter, which is mechanically coupled to the motor and is self-excited by means of the shunt field winding J. The circuit whereby the armature H of the exciter is connected with the series field winding D includes an iron core choke coil K. It is shown that with this arrangement the exciter and choke coil will maintain substantially constant the speed of the motor generator set in spite of variations in load and/or supply voltage.—*September 28th*, 1933.

№398,926

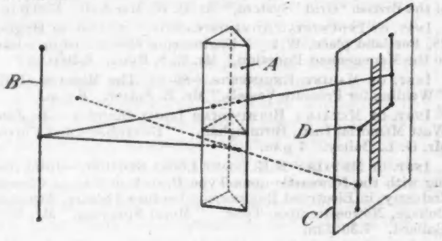


MEASURING AND TESTING INSTRUMENTS.

398,945. April 30th, 1932.—Gauge Glasses, P. E. Drosne, 35 bis rue du Chateau Asnieres (Seine), France, and Union d'Electricite, rue de Messina, Paris.

In this gauge glass advantage is taken of the relative refractive indices of water and steam to show up plainly the water level. The gauge glass A is prismatic and is illuminated by a strip-light B. The image produced on the screen C is shown at D, and emphasises the water line.—*September 28th*, 1933.

№398,945

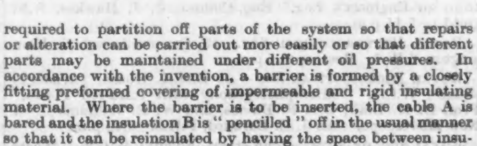


TRANSMISSION OF POWER.

398,920. April 1st, 1932.—Electric Cables, Siemens Brothers and Co., Ltd., of Caxton House, Tothill-street, Westminster, S.W.1, and James Riedl, of 48, Waverley-road, London, S.E.18.

In certain cable systems it may be required to interpose a barrier in the insulation to prevent longitudinal movement of the compound. For instance, in an oil-filled cable system in which channels are provided in the cable, in which oil or compound under pressure is situated and is in communication with the oil or compound in the cable insulation proper, it may be required to partition off parts of the system so that repairs or alteration can be carried out more easily or so that different parts may be maintained under different oil pressures. In accordance with the invention, a barrier is formed by a closely fitting preformed covering of impermeable and rigid insulating material. Where the barrier is to be inserted, the cable A is bared and the insulation B is "pencilled" off in the usual manner so that it can be reinsulated by having the space between insulated parts filled in as at C. The conductor is given a smooth and closed exterior, and is laterally closed against transfer of oil from one section to the other. This may best be effected by cutting the conductor and inserting the cut ends into recesses in a cylindrical metal body D. The insulating barrier E is made, in the first place, of coned shape, so that it is adapted to fit on to the pencilled insulation B. It may continue in cylindrical form F over the remaining insulation—that is, the insulation which has not been pencilled, to and over the covering or lead sheathing of the cable, or, alternatively, the insulating barrier may be continued over these parts and over the conductor in strip form. The space between the joint, when formed, and the joint sleeve is filled with oil or compound as at G. A method of applying the invention to a multi-core cable is also described.—*September 28th*, 1933.

№398,920



FURNACES.

399,064. January 25th, 1933.—Gas Burners, Gaz and Chaleur, 68, Boulevard Bourdon, Neuilly-sur-Seine (Seine), France.

In this gas burner the primary air for combustion is admitted through the passage A, and is thereby heated to some extent before it is mixed with the gas at B. A secondary supply of air is provided under the hood C, and through the holes D. This supply also is heated by radiation from the flame.—*September 28th*, 1933.

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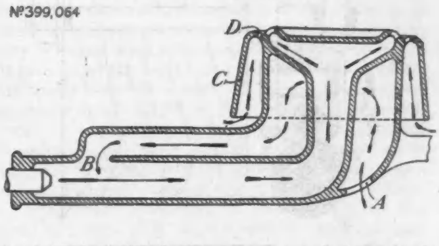

MACHINE TOOLS AND SHOP APPLIANCES.

399,094. February 23rd, 1933.—Screwdrivers, Robert Bosch Aktiengesellschaft, 4, Militärstrasse, Stuttgart, Germany.

A denotes the end of a motor-drive screwdriver; B is the screw to be driven in; C is a sleeve surrounding the screwdriver in which a holding device D is inserted. The holding device D is composed of a slotted springy ring E, in which four ball pins G are riveted at equal distances apart. A groove H is formed in the ends of the pins and serves for gripping the head of the button-headed countersunk screw B. The sleeve C, in which the holding device is mounted, is secured to the screwdriver in such a way that it can be drawn off the screwdriver without the use of tools. It is held by the pins J, which, like the pins G, are riveted to a slotted springy ring K mounted on the sleeve C. The sleeve can be pulled down from the part M by a single pull. When using the screwdriver for other screws, it can then be easily replaced by another sleeve having a holding device adapted to the new screws.—*September 28th*, 1933.

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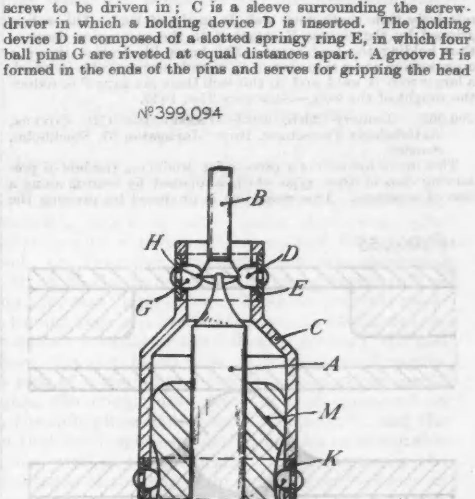

398,415. March 1st, 1933.—Making Steel Sections from Discarded Rails, London Works (Barlows), Ltd., Halesowen-street, Oldbury, and A. N. Mayer.

Structural sections rolled from old, worn railway metals have sometimes suffered from the disadvantage that they are liable to be cracked on account of the deformation to which they are subjected in re-rolling. The inventors meet the difficulty by first splitting the heated rail down the centre of

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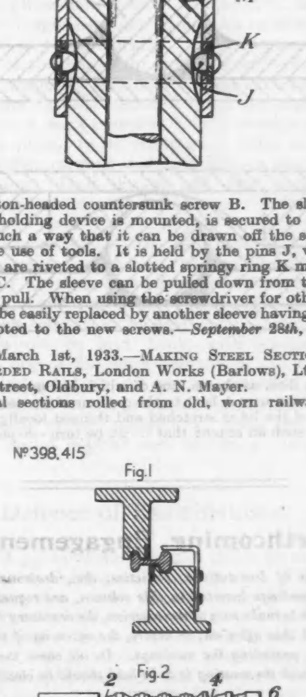
Fig.1

Fig.2

the web, as shown in Fig. 1, and then rolling the two halves, individually, in a series of passes, as shown by the numerals of Fig. 2. For heavy sections the passes 1, 2, 3 are used; for lighter sizes the passes may be either 1, 2, 3, 4, 5, or even include 6 and 7.—*September 14th*, 1933.

MISCELLANEOUS.

398,627. July 19th, 1932.—Electric Cables with Carrying Devices, Lynenwerk, Gesellschaft mit beschränkter Haftung, of Eschweiler, Kreis Aachen, Germany.

The upper illustration shows the invention applied to a multiple telephone cable A, the lead covering of which is connected with the lead covering B of the suspension cable C by means of a relatively thin continuous web D made of lead. The web is gripped by the clamps E attached to the suspension devices, thus holding the lead cover. The lower illustration shows a cross section and a side view of an outside electric cable in which a larger web is used and in this web there are gaps F to reduce the weight of the web.—*September 21st*, 1933.

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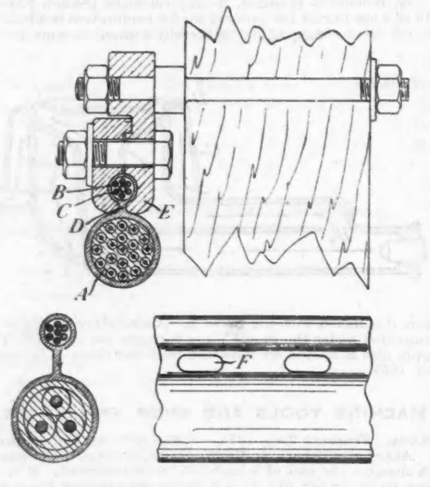

399,065. January 25th, 1933.—Preserving Can Covers, Aktiebolaget Transitoric, Birger Jarlsgatan 37, Stockholm, Sweden.

This invention covers a process for producing the lids of preserving cans of that type which is opened by tearing along a line of weakness. This weak line is produced by pressing the lid between dies, as shown, one of which has upraised upon it a piece of piano wire A bent to the contour of the tear required. The metal of the lid is stretched and thinned locally in way of the wire to such an extent that it can be torn—*September 28th*, 1933.

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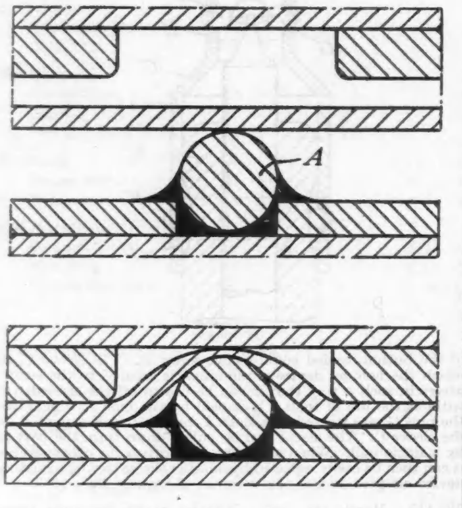

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day.

Inst. of British Foundrymen.—At the Cleveland Sciéntific and Technical Inst., Corporation-road, Middlesbrough. "Routine Methods of Testing Green Sands," Mr. N. D. Ridsdale. 7.45 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Discussion, "Financing Industry," introduced by Mr. Sydney Parkes. 7 p.m.

Inst. of Electrical Engineers: London Students' Section.—Victoria Embankment, W.C.2. "The Use of Electricity in Rural Areas," Mr. A. L. Cain. 6.15 p.m.

Inst. of Electrical Engineers: N.-Eastern Students.—Armstrong College, Newcastle-upon-Tyne. "Progress and Problems in Design," Mr. F. H. Williams. 7.15 p.m.

Inst. of Metals: Sheffield Local Section.—In Nonferrous Section of Applied Science Department of University, St. George's-square, Sheffield. "Metal Spraying," Mr. W. E. Ballard. 7.30 p.m.

Inst. of Structural Engineers: Midland Counties.—At James Watt Memorial Inst., Birmingham. "Military Engineering, 1915–1918," Mr. H. W. Coultas. 6.30 p.m.

Inst. of Structural Engineers: Scottish Branch.—At Grosvenor Restaurant, Glasgow. 6.30 for 7 p.m.

Inst. of Structural Engineers: Western Counties Branch.—At Merchant Venturers' Technical College, Bristol. "Some Test Results on Structural Steel Sections," Mr. Ewart S. Andrews. 7.15 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Annual general meeting. 7.30 p.m.

Keighley Assoc. of Engineers.—Queen's Hotel, Keighley. "Petroleum: From Well to Consumer," Mr. F. L. Slee. 7.30 p.m.

Manchester Assoc. of Engineers.—At Engineers' Club, Manchester. Discussions, "Foundation Bolts," Mr. A. C. Dean; "Why Inspect," Mr. W. A. Melhuish; "Destructive Tests: Their Use and Abuse," Mr. H. M. Leyland. 7.15 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse, Mr. N. V. Sidgwick. 9 p.m.

Saturday, November 11th.

Inst. of British Foundrymen.—Technical College, Monks-road, Lincoln. "Use of Refractory Materials in the Foundry," Dr. J. G. A. Skerl. 7 p.m.

Inst. of Electrical Engineers: N. Midland Students.—Visit to works of English Electric Company, Ltd., Leeds-road, Leeds. 2.15 p.m.

Inst. of Marine Engineers: Junior Section.—85-88, The Minories, E.C.3. Social and dance. 7.30 p.m.–11.15 p.m.

Inst. of Mech. Engineers: Graduates.—Visit to Brookman's Park Wireless Station. Particulars from Hon. Sec., Graduates' Section, 28, Essex street, Strand, W.C.2.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. "The Course and Causes of the World Depression," Mr. L. C. Robbins. 3 p.m.

Monday, November 13th.

Bradford Engineering Soc.—At Technical College, Bradford. "The Application of Experiment and Theory to Journal Bearing Design," Mr. H. L. Haslegrave. 7.30 p.m.

Chartered Surveyors' Inst.—12, Great George-street, S.W.1. Presidential address, Mr. Percival F. Tuckett. 8 p.m.

Inst. of Electrical Engineers: N.-Eastern Centre.—At Armstrong College, Newcastle-upon-Tyne. "The Lower-voltage Sections of the British 'Grid' System," Mr. C. W. Marshall. 7 p.m.

Inst. of Metals: Scottish Local Section.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Discussion on papers presented at the autumn meeting of the parent Institute. 7.30 p.m.

Inst. of Production Engineers, Manchester.—At College of Technology, Manchester. "Motion Study and its Application to Engineering," Miss A. G. Shaw. 7.30 p.m.

Inst. of Structural Engineers: S. Wales and Monmouthshire Branch.—At S. Wales Inst. of Engineers, Cardiff. "Dynamics of Bridges," Mr. C. J. Price. 7 p.m.

Stephenson Locomotive Soc. (Scotland).—In L.M.S.R. Societies' Room, Royal Technical College, Glasgow. "The Economic Life of the Locomotive," Mr. John Scott. 7.45 p.m.

Monday, November 13th, to Saturday, November 18th.

Public Works Congress and Exhibition.—Royal Agricultural Hall, Islington, N.1. Daily. (For programme see page 365).

Tuesday, November 14th.

Chemical Engineering Group.—At the Public Works, Roads, and Transport Exhibition, Royal Agricultural Hall, Islington, N.1. Conference, "The Mechanical Testing of Bituminous Road Materials." Sessions 11 a.m. and 3 p.m.

Hull Assoc. of Engineers.—At Municipal Technical College, Park-street, Hull. "The Mining and Handling of Asbestos," Mr. W. S. Blackie. 7.30 p.m.

Illuminating Engineering Soc.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Development of Aviation Lighting," Major R. H. S. Mealing. 7 p.m.

Inst. of Automobile Engineers.—At King's Head Hotel, Coventry. "Transmission Principles," Mr. L. H. Pomeroy. 7.30 p.m.

Inst. of Electrical Engineers: N. Midland Students.—Hotel Metropole, Leeds. "Training for the Electrical Supply Industry," Mr. J. N. Waite. 7.15 p.m.

Inst. of Electrical Engineers: Scottish Centre.—At 39, Elmbank-crescent, Glasgow, C.2. "The Lower-voltage Sections of the British 'Grid' System," Mr. C. W. Marshall. 7.30 p.m.

Inst. of Industrial Administration.—At Inst. of Hygiene, 28, Portland place, W.1. "Engineering Economics in relation to the Management Function," Mr. E. S. Byng. 6.30 p.m.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. "Welding for Pressure Vessels," Mr. R. Sulzer. 6 p.m.

Inst. of Metals: Birmingham Local Section.—In James Watt Memorial Inst., Birmingham. "Deoxidisers and Fluxes," Mr. G. L. Bailey. 7 p.m.

Inst. of Metals: N.E. Coast Local Section.—Joint meeting with the Newcastle-upon-Tyne Branch of Soc. of Chemical Industry, in Electrical Engineering Lecture Théatre, Armstrong College, Newcastle-upon-Tyne. "Metal Spraying," Mr. W. E. Ballard. 7.30 p.m.

Inst. of Metals: Swansea Local Section.—At Y.M.C.A., Swansea. "Ageing and Age Hardening," Dr. Cecil H. Desch, F.R.S. 6.15 p.m.

Inst. of Petroleum Technologists.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Some Notes on the Holley-Mott Continuous Counter-current Washery as applied to Petroleum Products," Mr. E. Thornton. 5.30 p.m.

Sheffield Metallurgical Assoc. — 198, West-street, Sheffield. "Intergranular Corrosion of 18/8 Austenitic Steels," Mr. E. C. Rollason. 7.30 p.m.

Wednesday, November 15th.

Inst. of Chemical Engineers.—At Chemical Soc., Burlington House, W.1. "The Utilisation of Wood for the Production of Foodstuffs, Alcohol and Glucose," Dr. F. Berguis. 6 p.m.

Inst. of Electrical Engineers: Meter and Instrument Section.—Pagani's Restaurant, 42, Gt. Portland-street, W.1. Annual dinner. 6.45 p.m. for 7 p.m.

Inst. of Production Engineers: Birmingham.—At James Watt Memorial Inst., Birmingham. "Trend of Machine Tool Design," Mr. I. H. Wright. 7 p.m.

Inst. of Production Engineers: Western Section.—Grand Hotel, Bristol. "Instilling Machine Shop Sense in the Drawing Office," Mr. F. Ayton. 7.30 p.m.

Manchester Metallurgical Soc.—At College of Technology, Manchester. "Hardness of Metals," Dr. H. O'Neill. 7 p.m.

N.E. Coast Inst. of Engineers and Shipbuilders: Graduates.—At Mining Inst., Newcastle-upon-Tyne. "Leaves from an Engineer's Log," Eng.-Commr. C. J. Hawkes, R.N. (retd.). 7.15 p.m.

Royal Meteorological Soc.—49, Cromwell-road, S. Kensington, S.W.7. Meeting at 5 p.m.

Royal Microscopical Soc.—At B.M.A. House, Tavistock-square, W.C.1. "Microphotography with Infra-red Plates," Prof. D. M. Blair, Drs. F. Davies, and W. E. Williams; "A New Microscope," Mr. J. E. Barnard, F.R.S. 5.30 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "Waste Products of Agriculture: Their Utilisation as Humus," Mr. Albert Howard. 8 p.m.

Thursday, November 16th.

British Waterworks Assoc.—Agricultural Hall, Islington, N.1. To receive and discuss the following papers:—"Pooling of Supplies by Interconnection of Water Undertakings and their Trunk Mains through Rural Areas," Mr. Alan E. L. Chorlton; "Water Pollution Research," Dr. A. Parker. 11 a.m. Afternoon session: "The Financial Management of Municipal Trading Departments," Mr. Sydney Larkin; "Water Supply and Fire Protection," Mr. John Smith; "Fire Prevention and Fire Extinguishing Apparatus," Major F. W. Jackson; "The Legal Aspect of Water Supply for Fire Protection Purposes," Mr. John Hall. 2.45 p.m.

Inst. of Production Engineers, Glasgow.—At 39, Elmbank-crescent, Glasgow. "Nitralloy Steel and Nitriding," Mr. J. McCrone. 7.30 p.m.

Manchester Assoc. of Engineers: Students.—At Y.M.C.A., Peter-street, Manchester. "The Testing and Inspection of Important Forgings and Castings," Mr. R. W. Bailey. 7.30 p.m.

N.E. Coast Inst. of Engineers and Shipbuilders: Teesside Branch.—At Cleveland Scientific and Technical Inst., Middlesbrough. "Rudder Stream-lining Technique," Dr. E. V. Telfer. 7.30 p.m.

Royal Aeronautical Soc.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Problems Involving the Stiffness of Aeroplane Wings," Dr. H. Roxbee Cox. 6.30 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "The Application of Electricity to Agriculture and Horticulture," Dr. S. S. Nehru. 4.30 p.m.

Societe des Ingenieurs Civils de France: British Section.—Club Room, Public Works, Roads and Transport Congress and Exhibition, Royal Agricultural Hall, N.1. "Modern Road Developments in France," Monsieur P. Le Gavrian. 5.30 p.m.

University of London.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: v., Ignition and Combustion Properties of Fuels," Dr. S. J. Davies. 5.30 p.m.

Friday, November 17th.

Finsbury Technical College Old Students' Assoc.—At Inst. of Chemistry. Sixteenth Streatfield Memorial Lecture, "Beer," Mr. H. F. E. Hulton. 8 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. "Heat Liberation and Transmission in Large Steam-generating Plants," Messrs. E. W. Robey and W. F. Harlow. 6 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Recording Sound for Motion Pictures," Mr. W. Harris. 7.30 p.m.

N.E. Coast Inst. of Engineers and Shipbuilders.—At Mining Inst., Newcastle-upon-Tyne. "Tramp Ship Design: An Owner's Views and Requirements," Mr. W. L. Runciman. 6 p.m.

Overhead Lines Association.—At Georgian Restaurant, Harrods, Ltd. Annual conversazione.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse by Sir Herbert Baker. 9 p.m.

Saturday, November 18th.

Inst. of Electrical Engineers: N. Midland Students.—Visit to works of P. Garnett and Sons, Ltd., papermakers, Otley. 3 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. "The Course and Causes of the World Depression," Mr. L. C. Robbins. 3 p.m.

Monday, November 20th.

Inst. of Electrical Engineers: Western Centre.—At Cheltenham. Discussion on "Gale and Storm Damage." Opener, Mr. W. D. Tuck.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Oil-fired Furnaces," Mr. R. H. B. Forster. 6.45 p.m

Tuesday, November 21st.

Inst. of Automobile Engineers.—At Victoria Hotel, Wolverhampton. "The Correlation of Metallurgical and Economic Problems in the Selection of Automobile Engineering Materials," Mr. L. B. Hunt. 7.30 p.m.

Sheffield Metallurgical Assoc. — 198, West-street, Sheffield. Discussion, "Rolling Faults in Steel," Mr. G. M. Brown. 7.30 p.m.

Wednesday, November 22nd.

Inst. of Automobile Engineers.—At Engineers' Club, Albert-square, Manchester. "Transmission Principles," Mr. L. H. Pomeroy. 7 p.m.

Inst. of Structural Engineers: Scottish Branch.—At 129, Bath-street, Glasgow. "Specification Problems," Mr. A. Leitch. 7.30 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "Radiographic Use of Radium," Dr. V. E. Pullin. 8 p.m.

Thursday, November 23rd.

Annual Chemical Dinner.—Wharncliffe Rooms, Hotel Great Central, Marylebone, N.W.1. Dinner, 7.30; dancing, 9.15 p.m.

British Science Guild.—In Goldsmiths' Hall, Foster-lane, E.C.2. Norman Lockyer Lecture. "Empire Communication," Professor E. V. Appleton, F.R.S. 4.30 p.m.

Inst. of Mechanical Engineers: Yorkshire.—At Queen's Hotel, Leeds. Chairman's address, Mr. A. N. Gledhill. 7.30 p.m.

Inst. of Structural Engineers.—10, Upper Belgrave-street, S.W.1. "Building Regulations," Mr. C. Roland Woods. 6.30 p.m.

Sheffield Metallurgical Assoc. — 198, West-street, Sheffield. "Applications of X-rays to Metallurgical Investigations," Mr. J. W. Rodgers. 7.30 p.m.

University of London.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: vi., Designs of Combustion Chambers—Actual Performance—Trends of Development," Dr. S. J. Davies. 5.30 p.m.

Friday, November 24th.

Inst. of Structural Engineers: Midland Counties.—At James Watt Memorial Inst., Birmingham. "Designing for Welding," Mr. C. Helsby. 7 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Refrigerating Machines and their Applications," Mr. W. S. Douglas. 7.30 p.m.

Monday, November 27th.

Engineers' German Circle.—At Holborn Restaurant, W.C.1. Dinner and dance. Reception, 7.30 p.m.

Tuesday, November 28th.

Inst. of Electrical Engineers: Scottish Centre.—Grosvenor Restaurant, Gordon-street, Glasgow, C.2. Annual dinner and ladies' evening. 6.30 p.m. for 7 p.m.

Thursday, November 30th.

Inst. of Civil Engineers: Yorkshire Assoc.—Hotel Metropole, Leeds. Short paper by students for discussion. "Tramway Reconstruction," Mr. C. R. Warman; "An Economic Aspect of Reinforced Concrete," Mr. E. A. Dyer. 7.30 p.m.

Inst. of Metals: Birmingham Local Section.—In James Watt Memorial Inst., Birmingham. "Symposium on Defects in Cold Working," arranged by Mr. A. L. Molineaux. 7 p.m.

A Seven-Day Journal

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Larger Cruisers.

The First Lord of the Admiralty, Sir Bolton Eyres-Monsell, announced in the House of Commons on Tuesday last that the Government had decided with much regret and after mature consideration to modify the 1933 cruiser-building programme, in view of the fact that the British efforts to secure world disarmament and the reduction in the size of warships had not met with the anticipated response by other nations. The programme originally comprised four cruisers, one "Leander" of 7250 tons, and three "Arethusas" of 5400 tons each; the number is now to be reduced to three, the "Leander" being retained and the three "Arethusas" being replaced by two cruisers of a new type, with a displacement of 9000 tons each and larger armament. In making this announcement, the First Lord reminded the House that in 1931 Japan laid down two cruisers of 8500 tons, with fifteen 6in. guns. Her programme includes six ships of this class. The United States, he added, had decided to build four cruisers of 10,000 tons, also armed with fifteen 6in. guns. In 1932 the United Kingdom put forward at Geneva the proposal that future cruisers should be reduced to 7000 tons, with a maximum gun calibre of 6·1in., but the proposal was not adopted. "If, therefore," continued the First Lord, "our programme, already approved, were to be carried out, the new cruisers would be definitely inferior to those being developed by other Powers." Hence the decision to build two large, instead of three small, cruisers, thus keeping within the terms of the London Naval Treaty, and not exceeding the original Estimates.

Encouraging the Use of Steel.

The mission of the British Steelwork Association is to popularise the use of British steel. Hence it was only fitting that the speeches at its annual luncheon should be of a more businesslike character than is usual at similar functions. Mr. Walter Runciman, the Minister for the Board of Trade, took great pains to answer the question many steel makers have asked as to the security they may expect by a prolongation of the present import duties, and whilst denying that he had committed himself, expressed his belief that neither this nor any future Government would remove the present protection afforded the industry. Mr. Ben Walmsley, the chairman, spoke with confidence of the continued improvement in the steel trade, and advocated the greater use of advertisements as an aid to propaganda. He referred to the rivalry between cement and timber and other forms of construction, and pointed out the necessity for an active campaign in favour of the association's own products. He instanced the field that was open to them by the great programmes of slum clearances. Sir Henry Maybury, President of the Institution of Civil Engineers, in responding for the guests, said there were between 6000 and 7000 weak bridges which were unsuitable for the transport of the country, of which he thought reconstruction should be taken in hand. If that were done, it might provide work for some of the unemployed young engineers. Sir William Ray pointed out that much could be done by municipal bodies to stimulate business activity by revising the present Building Acts and bringing them up-to-date and into line with modern requirements.

Rural Electrification Schemes.

According to the thirteenth annual report of the Electricity Commissioners, issued last week, during the year ending March, 1932, transmission and distribution lines were added to the Bedford demonstration rural electrification scheme. The approximate total route length of the overhead and underground transmission and distribution lines provided in the demonstration area at the end of the year was 204·8 miles, inclusive of about 64·2 miles of lines which were erected or laid prior to the official commencement of the scheme. The revenue from the sales of electricity in 1932–33 showed an increase of £4193, or over 29 per cent. on the revenue of the preceding year. It will be remembered that the scheme was put into operation in 1930, and while it has shown a gross surplus in each year the net result after providing for capital charges was a small net surplus in the first year and deficits in the next two years. Results of this character were anticipated, it being recognised that under an intensive programme of development involving both rapid capital expenditure and substantial revenue expenditure on propaganda the scheme would have to bear somewhat heavy charges in the early years which would not be immediately reflected in the amount of revenue received. Some measure of relief was afforded, however, by the suspension of sinking fund payments under consents of the Commissioners in respect of a part of the loans raised for the scheme. As regards the Norwich demonstration scheme, at the end of December, 1932, the high-tension transmission system was practically complete, while at the end of March, 1933, low-tension supplies had been made available to consumers in forty-six out of forty-nine parishes in the area. As in the case of the Bedford scheme, however, that at Norwich was based on a programme of rapid construction and intensive development involving heavy initial charges, and the financial results for the two years' working leave much to be desired.

New Shipbuilding Orders.

At the beginning of the week the Blue Star Line announced that it had decided to place orders in Great Britain for two large ships for the United Kingdom–New Zealand trade, into which it has entered since the signing of the Ottawa Agreements. It will also bring into operation in this trade two other ships, one of 10,000 tons and the other of 9000 tons. At the present time there are under construction in British shipyards several large refrigerated cargo liners which are to be used for New Zealand services. It is anticipated that the new fleet engaged in this trade will have a tonnage close upon 80,000, and that this tonnage, together with reconditioned vessels, will make over 100,000 tons of shipping. Other new orders on the Clyde include a 10,000 gross ton passenger and cargo liner to be built by Alexander Stephen and Co., Ltd., for the Adelaide Steamship Company, Ltd., which will be propelled by twin-screw Kincaid B. & W. type oil engines. Three cargo ships have been ordered on the Clyde by Maclay and McIntyre, Ltd., of Glasgow, one of which will be propelled by the new Stephen three-cylinder compound engine described in The Engineer of October 27th last. Of the other two ships, one will be built and engined by D. and W. Henderson and Co., Ltd., of Partick, and the other will be built by Lithgow's, Ltd., of Port Glasgow, and engined by David Rowan and Co., Ltd., of Glasgow. All three ships will have a deadweight carrying capacity of about 5000 tons each. At Dumbarton, William Denny and Brothers, Ltd., will build an oil-electric ship for David MacBrayne's Portree service, which will be equipped with Davey Paxman G.E.C. machinery. Another announcement recently made is to the effect that the Ailsa Shipbuilding Company, Ltd., of Troon and Ayr, is to build a passenger and cargo steamer for Bristol Channel owners.

Improved Trade Returns.

The official trade returns for the month of October, which have just been issued, show clearly a continuance of Britain's reviving overseas trade. The imports were £66,771,000, representing an increase of £1,004,261 over the figures for October last year. There was also an increase of a little over three million pounds in the imports of raw materials and a small increase in the importation of manufactured foreign goods, which totalled £14,187,000, or only a little over half the figure of £27,249,000 for October, 1931. The export figures were also encouraging, amounting to £38,702,000, which was an increase of four and a-half million pounds compared with last year. The exports of British products amounted to £34,131,000 and increased by £3,691,000, while the sales of British manufactured goods amounted to £26,076,000, showing an increase of nearly £3,400,000. All the leading industries participated in the increase, notably the coal, iron, steel, and non-ferrous metals industries, and also motor cars, chemicals, and machinery manufacture. For the ten months of the present year imports amounted to £549,424,000, equal to a decrease of £31,540,000 compared with last year, while the exports of British produce and merchandise were actually larger, being £302,527,000, as against £301,548,000 in the corresponding ten months of 1932. If re-exports are taken into account, however, there was a small decrease amounting to £165,000 for the month.

The Uses of Coal.

On Wednesday, November 8th, in the course of an address given to the British Road Tar Association in London, Sir David Milne Watson said that national prosperity would return with an extension and a fuller appreciation of the importance of coal carbonisation. Great Britain already produced, he said, 30,000,000 gallons of motor fuel from coal annually, but more than 900,000,000 gallons of refined motor spirit still had to be imported from abroad. In meeting the competition from oil, and in placing coal in a more acceptable and convenient form for the provision of light, power, and heat, the gas and by-product coking industries could, he suggested, act as an indispensable medium of distribution. The gas industry had long been pressing for release from the shackles of obsolete legislation, and he hoped that the day was not far distant when it would be given the opportunity of meeting competition on equal terms. From the coal mine to the carburetter was no idle dream, as the present production of motor fuel from coal proved; again, the increasing use of compressed gas in steel cylinders was an important contribution to the motor transport problem. Referring to the use of British tar, Sir David stated that nearly double the former quantity of home-produced tar was now being utilised on the roads, in the face of keen foreign competition, which was itself a tribute to the lasting qualities of British coal.

Railway Companies' Road Vehicles.

On Thursday last, November 9th, in an address delivered at the Commercial Motor Transport Exhibition, Mr. J. Shearman, the road motor engineer of the London, Midland and Scottish Railway Company, defined some of the requirements of the four group railway companies with regard to road transport vehicles. He emphasised that they were probably different from those of the majority of other operators in that the companies were concerned mainly with delivery services with a limited radius of action, the major portion of the haul being by rail. For the kind of duty under discussion, said Mr. Shearman, ease and cheapness of repair might be more desirable than low first cost or an attractive appearance. A machine which could run, say, 50,000 miles under short mileage and frequent stop conditions without heavy repairs or extensive dismantling would be economical to maintain, even though it might require the overhaul of every unit at the end of that mileage. Synchronisation of the repairs to important parts was the most economical method of maintenance, and in order to ensure that the various parts would require overhaul at the same time, special materials, such as nitrided cast iron and alloy steels, would have to be employed in the case of rapid wearing parts. With regard to the oil engine, Mr. Shearman said that it was early as yet to compare the oil engine with the petrol engine for road transport vehicles, but it seemed possible that its mechanical reliability would be found to be quite as high as that of the best petrol engine.

Oil-Engined Fishing Craft.

The steady increase in the use of British-built oil engines for the propulsion of fishing craft, and the need for the reorganisation of our herring and fishing industries, which is now under discussion, give importance to a review of oil-engined fishing craft which, on Thursday, November 9th, was presented by Mr. A. C. Hardy before the Grimsby Institution of Engineers and Shipbuilders. The slow progress made by the internal combustion engine was attributed by the author to some of the following causes: the bad failure of a ship fitted with an early type of engine, the lack of a simple and easily understood design of engine, the competitive price of coal compared to oil, the difficulties of the trawl winch drive, and the fact that until eighteen months ago the most suitable engines were of foreign origin. After discussing the advantages of the oil engine and the wide choice of design now available, Mr. Hardy sketched the motor trawler of the future. Such a ship, he suggested, might well be a high-powered fishing machine, with refrigerating plant, radio compasses, echo sounder, and all the other modern scientific aids to navigation and to fishing. Hull design had also undergone changes which were shown by the more recent adoption of special hull forms, cruiser sterns, special rudders, and propellers. The trawler of to-day was, Mr. Hardy said, essentially a naval architect's problem, and no mere rule-of-thumb structure. It was generally agreed that large reconstruction programmes must soon be embarked upon, and that the new ships would be laid down with economy of operation as one of the main features of design. An owner who adopted an oil engine-propelled vessel could rest assured, on the grounds of proved economy compared with steam machinery, that he would recover his initial capital cost within a reasonable time.

A Defence of Examinations.

At the first public distribution of prizes at the City of Birmingham Commercial College, on Tuesday, November 7th, Sir Josiah Stamp made a vigorous defence of the examination system. It had been suggested, he said, that men would work just as well without any such incentive, that cramming did no good, and that examinations did not test many of the qualities required in the knowledge of life. In so far as cramming meant that a man had to master the essentials of a subject quickly, and not waste time on non-essentials, it was a very desirable quality for business. Between two men, one of whom was philosophical and the other quick in turning to what was required at the moment, he knew whom he would choose. The examination test, he said, drove men to their full powers, and was a corrective to self-deceit. A certain discipline was wholesome for every human being, and examinations taught the lesson to put the first things first. Subjects were not so much the flowers and the fruit, but the enrichment of the soil from which the flowers and fruit would grow. Sir Josiah paid a tribute to the combined courses of study arranged by the College, its close association with the University, and the facilities it offered for entry into professional life.

Recent Hydro-Electric Power Plants in Sweden.

No. II.

(Concluded from page 451, November 10th.)

VARGON HYDRO-ELECTRIC POWER STATION (*continued*)

The Power Plant.—The low head of water available at Vargön has the effect of making the costs of the civil engineering constructional work relatively high in terms of kilowatts installed. It has, however, been possible to reduce these costs by simplifying the constructional plans. Moreover, the regulating works at Vargön, comprising the barrage and sluice gates, in addition to being necessary accessories to the power plant, directly benefit the Trollhättan and Lilla Edet installations and increase the potential capacity of both of those plants. The features of the Vargön design, which exhibit some departure from the practice hitherto followed in Sweden and result in economy, are chiefly :—(*a*) The two turbine units at present installed are of unusually large dimensions, the runners being 8 m. diameter, as compared with 7·42 m. in the case of the four Kaplan turbines in the Svir plant in Russia, before then the largest in the world ; (*b*) the intakes to the turbines are designed on the syphon principle and it has been possible to dispense with gates ; (*c*) there is no power-house over the generators, which are of the semi-open air type, protected from wind and weather by removable sheet iron covers.

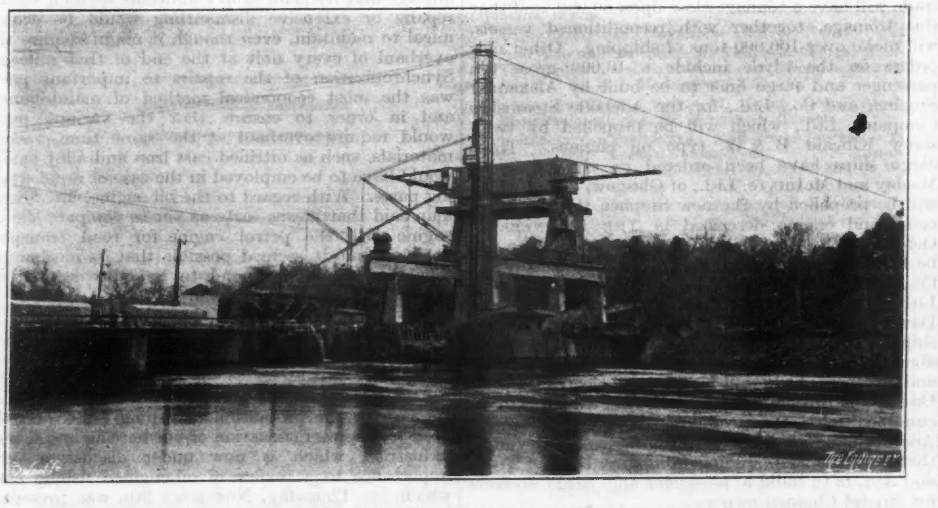

FIG. 15—REGULATING BARRAGE AND POWER STATION FROM UPSTREAM—DECEMBER, 1932

A travelling portal crane of 200 tons lifting capacity—on two hooks—has been constructed to run on rails on the roof of the turbine house. This crane is being used for the erection of the machinery and will be retained for permanent service when required. On each side of the portal is a 6-ton derrick crane, and there is also an auxiliary 10-ton lift on the main travelling winch. The crane has an overhanging roof and screens at the sides, which can be lowered to provide complete protection for the machinery when the cover is removed from a generator for inspection or repair of any of the machinery. The tracks of the portal crane are extended from the power station towards the land on the west side, passing over a small barge basin and storage yard—Fig. 8 (*ante*)—both of which lie within the hoisting range of the crane. The tracks are carried over the basin and yard on a reinforced concrete gantry affording ample headroom—Fig. 15. The barge basin is required because there is no direct connection with any railway. Heavy articles are sent *viâ* Trollhättan, where they are loaded from steamer or railway truck into barges for transport to Vargön. The crane and gantry can also be seen on the left of the view—Fig. 19, page 494.

Constructional Work of the Turbine Pit, &c.—The concrete in the turbine foundations, intakes, &c., including all the reinforced concrete work, contains 375 kilos. cement per cubic metre of concrete. Great care has been taken to ensure an impermeable concrete by suitable grading of the aggregates as well as by the sufficiency of the cement content. The air-tightness of the concrete in the spiral casing and the roof over the turbine runner is obviously of great importance because of the evacuation of air from the syphon which we refer to hereafter.

In the construction of large masses of concrete, such as occur in the water passages and other parts of the turbine house, where some of the spans are as much as 20·5 m., it is preferable to avoid expansion and contraction joints. When this practice is followed it is of great importance that the heat rise of the concrete during the period of hardening should be kept as low as possible, and lower than that of concrete made with normal Portland cement, in order to minimise the risk of shrinkage cracks. The cement used in the Vargön works by the Royal Board of Waterfalls has been specially manufactured at the Limhamm Cement Works. It is a Portland cement, somewhat richer in silica than the normal cement, has a long setting and hardening time, and slow rise in strength but high final strength. It has a lower and less rapid temperature rise and less shrinkage than normal cement, and is more resistant to acid waters. The slow-hardening cement is otherwise equal to normal cement in physical characteristics and attains the same strength in about two months.

The total volume of concrete, nearly all reinforced, in the power station structure is about 12,500 cubic metres. The weight of the steel reinforcement is 2300 tons. The average weight of reinforcement is therefore about 184 kilos. per cubic metre of concrete, an exceptionally high value. The magnitude of the steel reinforcement built into the concrete of the turbine pit will be realised from the view—Fig. 21, page 494—of the lower guide wheel ring and the supporting columns for turbine No. 1. The position of the second turbine can be seen in the background. Fig. 20, page 494, shows the steel liner for the draught tube of No. 1 turbine in course of erection.

The waterways are made comparatively narrow, especially at the intake and at the spiral ; but, in order to facilitate the flow as much as possible, these waterways are constructed without any dividing walls. The intakes and diffusors (or draught tubes) therefore have unusually large spans—at some sections more than 20 m. This arrangement and the heavy loads which have to be carried by the roof of the turbine chambers have necessitated rather heavy reinforced concrete construction.

In the absence of ordinary sluice gates the intakes can be closed, when it is necessary for the purpose of examination or repairs, by means of vertical stop logs or needles. By means of built-up sections, consisting mainly of rolled steel joists, a structure can be put in position which has the same effect as steel sheet piling. Similar needles are provided for closing the draught tube outlets when required. When the needles are not in use they are stored on top of the intakes and draught tubes. The needles, which are placed in position by means of the derrick cranes on either side of the main travelling crane, and the sills against which they bear, are indicated in the cross section—Fig. 17. The intakes and the draught tubes, if repairs should be necessary, can be pumped out when the temporary needle dams are in position. For this purpose openings for the passage of submersible pumps are formed in the concrete roofs and drainage sumps have been cut in the rock floor. These openings can be plumbed by one or the other of the 6-ton derrick cranes.

The granite rock in which the lower parts of the intakes and draught tubes are excavated is very compact and free from important fissures. It was therefore decided to dispense with concrete linings and to dress the granite, wherever practicable, to form the walls and floors of the water passages—see Figs. 17 and 22. When excavating the rock, blasting was carried out with special care to avoid disturbance of rock which was to form a finished face. As the face was approached holes were drilled closer together and small charges were used for blasting. After the rock had been blasted away as close to the final face as was safe, further cuts were made by closely placed drill holes and chiselling out. The final dressing of rock surface is fine axed work. Fissures and holes in the granite, where they occurred, were filled with cement applied by a cement gun. A view of the rock excavation for the draught tube of unit No. 1 is reproduced in Fig. 22, page 494.

THE KAPLAN TURBINES.[*]

The general arrangement of the No. 1 unit, the first to be erected, is shown in the cross section and plan—Fig. 17. The two units are generally similar, the prin-

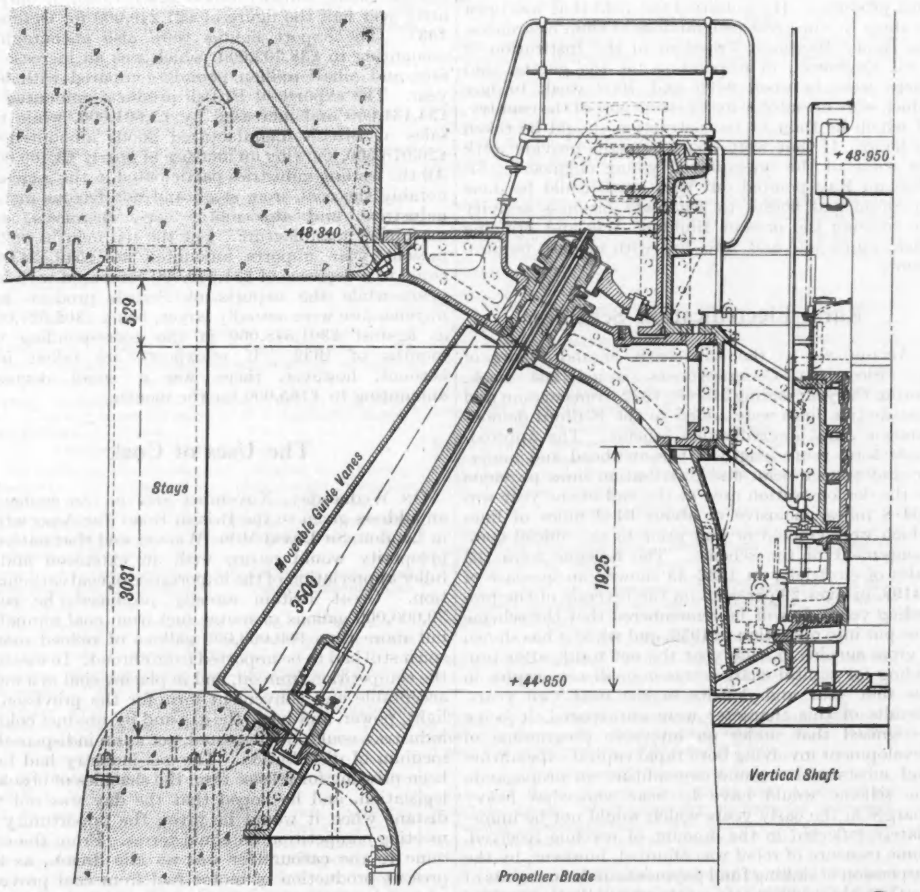

FIG. 16—PART OF CONICAL GUIDE APPARATUS OF KAPLAN TURBINE NO. 2—VERTICAL SECTION

cipal difference being that No. 2 has a conical guide apparatus, a detail of a part of which is reproduced in Fig. 16. It is intended that ultimately there will be three turbine units at the station. The following are the main particulars of the first and second units :—

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[*] A good description of Kaplan turbines and recent Swedish practice will be found in "Report No. 86," by E. Engelsson, World Power Conference Papers, Scandinavian Meeting, 1933.

Manufacturers : No. 1, Verkstaden Kristinehamn (in co-operation with Boving and Co., London); No. 2, Verkstaden Kristinehamn and Nydquist and Holm (Nohab).

Effective head, 4·3 m.

Rating H.P.: No. 1, 15,200 ; No. 2, 14,800.

Discharge : No. 1, 330 cubic metres per second ; No. 2, 320 cubic metres per second.

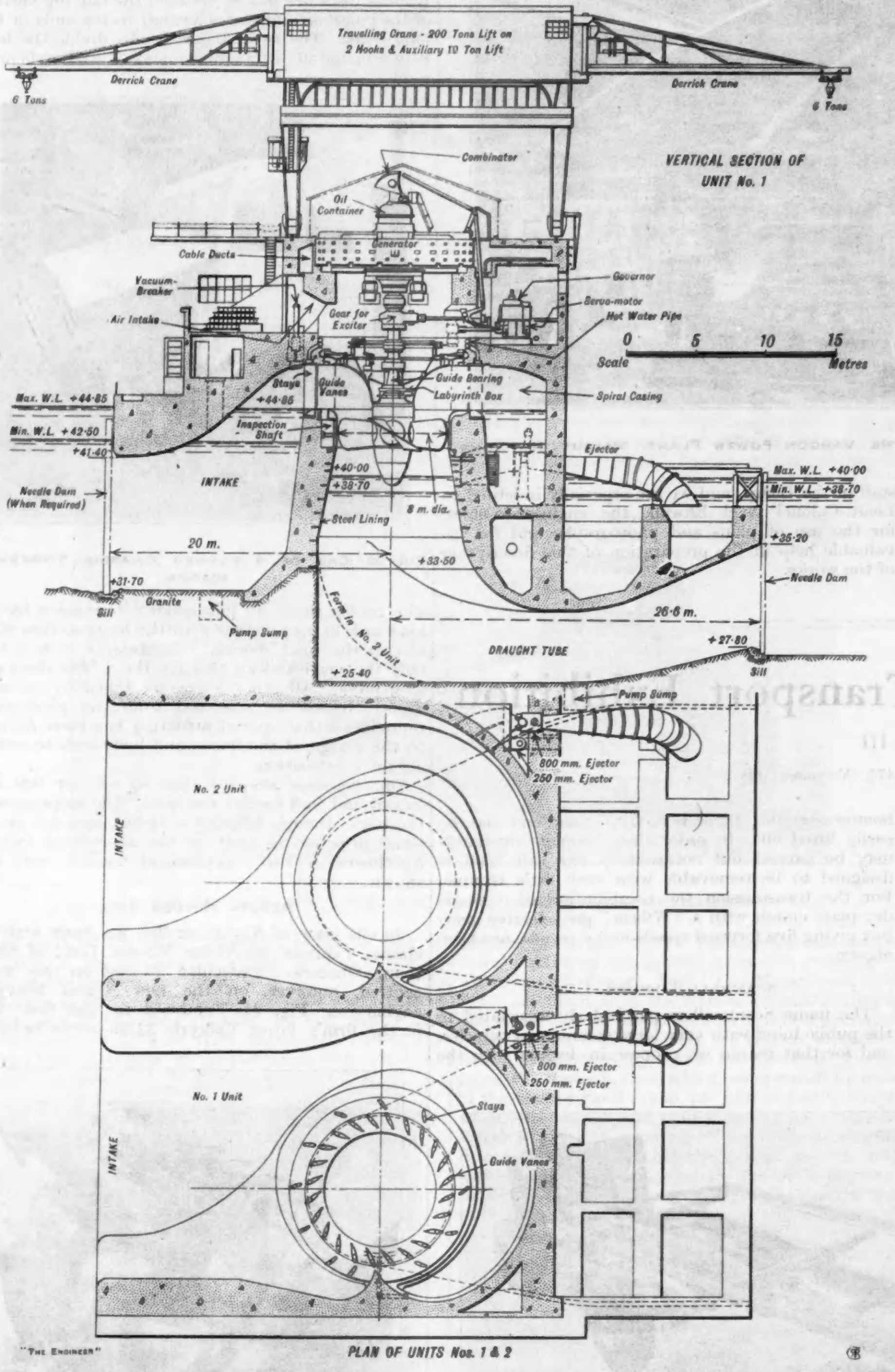
Diameter of runner, 8·0 m.

Diameter of hub, 2·94 m.

Weight of runner, 164 tons.

Speed, 46·9 r.p.m.

As already mentioned, the turbines are set above normal water level—that is, even at the maximum head water level the water does not rise above the guide-wheel foot. Before starting up the turbine water must be raised into the spiral casing by the ejectors. These have been arranged so that all four—see plan, Fig. 17—can serve one spiral casing. The small ejector in each turbine set is used to expel the air that gradually accumulates in the spiral casing during running. With this setting no intake sluices or gates are required. By admitting air into the spiral casing the water level in it can be lowered in a few seconds and the turbine ceases to get water. For this purpose there are two ports in the roof of the spiral çasing having together a sectional area of ½ square metre. Owing to the large dimensions of the turbines no trash racks have been provided at the intake ; consequently it is intended that all solids entering the intake shall pass through the turbines. The guide wheel cover is supported by twelve cast steel columns, which, as well as the guide vanes around the guide apparatus, are hollow. Provision is made to heat both the column and vanes, when necessary, by hot water to prevent the formation of ice. As the turbine will always work with a high vacuum, the labyrinth box has been submerged in a water container to prevent the admission of air.



IG. 17—VARGON HYDRO-ELECTRIC POWER STATION. KAPLAN TURBINE INSTALLATION—SECTION AND PLAN

Specific speed : No. 1, 934 ; No. 2, 922 ; (metric units).

Number and material of blades, four stainless steel, chipped and ground.

Draught tube type ; No. 1, Kaplan, square cornered elbow ; No. 2, Kaplan, curved elbow.

The gross head varies from 6·5 m. to 1·8 m. When the regulation has been completed the average head will be about 4·3 m. The maximum output of No. 1 turbine unit is 19,400 H.P. at 5·7 m. head. At 4·3 m. head the following efficiencies have been guaranteed :—

13,800	11,040	8280	5520	3460	H.P.
84·3 ..	88·5 ..	90·0 ..	88·2 ..	83·8%	efficiency

The lowest upper water level is at +42·50 m., and by means of the ejector it is raised to level +48·052.

The design of the turbine setting adopted for Vargön enables the machine to be closed down rapidly by admitting air into the spiral casing in the manner already mentioned. When the load is suddenly thrown off air is admitted into the draught tube in order to avoid water hammer. The air inlet ports are operated by an overspeed pendulum. On each turbine pit there are two hydraulically operated vacuum breakers affected by the overspeed pendulum. Thus, if the turbine should develop 50 per cent. overspeed, both vacuum breakers would open and in a few minutes they would admit enough air into the turbine pit to lower the water to the original level and the turbine would stop. The combinator with oil container is placed on top of the generator and is linked up with the governor by means of connecting-rods. Any guide wheel opening corresponds to a predetermined position of the runner blades and the different positions of the runner blades have been tested experimentally to give the best efficiency.

The regulating mechanism for the runner blades and the hub design are practically the same as have been used by Verkstaden Kristinehamn for all Kaplan turbines built in the past ten years. The design is characterised by the servo-motor being placed in the hub itself, the pressure oil being brought to the servo-motor by means of the hollow operating rod for the regulating valve in the motor. The runner blades are carried partly by a central trunnion to take the loads at right angles to the blades' turning axis, and partly by an outer bearing ring which takes care of the overhang. The hub is filled with oil under pressure, which is greater than that of the surrounding water, and so helps to prevent the ingress of water to the hub. A suitable double-acting tightening arrangement prevents oil from leaking out at the blade flanges and water or dirt from entering. The runner chamber is cylindrical. The second turbine has a conical guide apparatus and is built by Nydquist and Holm, but its runner has been made by Verkstaden Kristinehamn, who are responsible for the efficiency of both turbines.

The governor and its accessories are placed in spaces around the generator pit. The governor equipment consists in the main of the following parts : Air vessel ; oil reservoir ; pump ; regulating shaft and the servo-motor on which the pendulum and the regulating valve, as well as the other operating gears, are installed.

For the pressure oil supply there are two gear wheel pumps of different sizes. The large pump is connected direct to the exciter, which in turn is driven from the turbine shaft by means of bevel gears. This pump is normally running with no load. On the oil reservoir there is a small motor-driven pump, which is intended to supply the oil required under normal conditions when running and also when starting the turbine. The servo-motor is connected to the guide wheel regulating ring by means of connecting-rods and the regulating shaft, and is also operated by the system of connecting-rods and levers forming the combinator.

The pendulum is motor driven, current being supplied by a small generator on the shaft driving the exciter. If the pendulum motor circuit should fail, the guide wheel operation is locked. If the oil pressure in the air vessel should fall below a predetermined value, the turbine will be closed down. This, of course, also happens if the turbine attains a runaway speed. In the latter case also the vacuum breakers are opened. When any of the safety devices are in operation suitable signals are given and a signal is also made in the case of high temperature in the bearings.

Some idea of the huge dimensions of the turbines may be gained from the statement that each runner blade weighs 11 tons and the complete runner—Fig. 18—has a weight of 164 tons. The blades are of stainless steel and the runner chamber is made of welded steel plates. The use of stainless steel for the blades of Kaplan turbines has now become the normal practice in Sweden,* and both German and Swiss makers of Kaplan turbines are beginning to use this material for plants operating under relatively high heads. In the Vargön plant, not only are the runner blades of stainless steel, but also the upper part of the draught tube lining—that is, the section below the cylindrical runner chamber.

Generators.—Each turbine will be coupled to a three-phase generator rated at 12,000 kVA, 11 kV. One of the units is arranged for 25 c.p.s. and the other for 50 c.p.s. The 25-cycle unit will be connected with Trollhättan by means of an existing 11-kV line, while the 50-cycle unit will deliver energy to an outdoor 11/55-kV transformer for 12,000 kVA connected by a new line to the power station in Trollhättan. A motor generator and a storage battery for direct-current requirements will also be installed at the Vargön station.

The reason for the equipment of a new station with both 25 and 50 cycles machines is that the large industrial plants of the Vargön Aktiebolag nearby are equipped for 25 cycles and practically the whole output of one generator can be absorbed by them.

Distant Control.—The Vargön power plant will be controlled from the control room at the Trollhättan plant, 10 kiloms. lower down the river. From there the regulating gates in the barrage will be operated and the running of the turbines controlled.

The generators and other electrical equipment are being made by the Allmänna Svenska Elektriska Aktiebolaget, Västeras.

CONCLUSION.

The cost of the whole of the works at Vargön is expected to be about 14 million kronor (about

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* See "Pitting in Water Turbines," Engelsson ; THE ENGINEER, October 17th, 1930.

£770,000 at par). Of this sum about 9 million kronor have been or will be spent on the power house and plant. The cost of the cofferdams for the power-house foundations was about 490,000 kronor, which appears to be a very moderate expenditure on such a difficult and complicated piece of work. Of this sum, 430,000 kronor is the expenditure on the upstream and downstream steel cofferdams, the balance being spent on a timber cofferdam on the east side of the power-house.

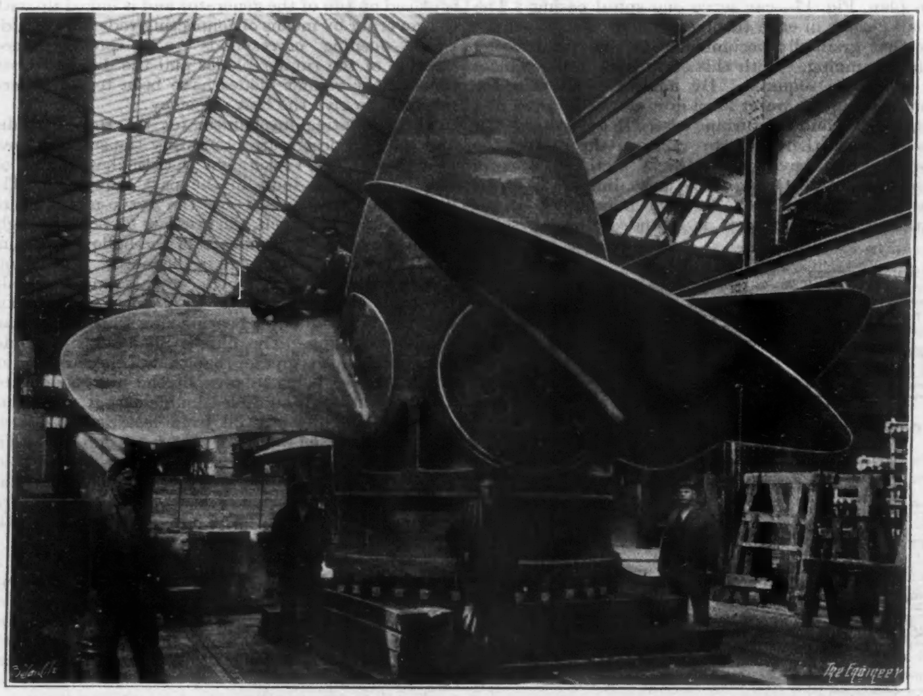


FIG. 18—KAPLAN RUNNER, 8 M. DIAMETER, FOR THE VARGON POWER PLANT. WEIGHT 164 TONS

The constructional works are being carried out by the Engineer's Department of the Royal Board of Waterfalls without the intervention of a contractor. All the works have been designed by the engineering staff of the Board, and we are especially indebted to Lieut.-Colonel Axel Ekwall, the engineer-in-chief, for the use of plans and photographs and for his valuable help in the preparation of this description of the works.

Commercial Motor Transport Exhibition.

No. III.

(Concluded from page 475, November 10th.)

THE YORKSHIRE PATENT STEAM WAGON COMPANY, LTD.

ON the stand of the Yorkshire Patent Steam Wagon Company, Ltd., of Hunslet, Leeds, there was shown an oil engine driven chassis having a load capacity of 6 tons. The makers state that for some time they have been observing the progress of the high-speed oil engine, and that they are now satisfied that this form of prime mover has reached a reasonable finality in design. It will be seen from the reproduced photograph, Fig. 29, that forward control has been adopted. The Dorman-Ricardo four-cylinder engine, developing 75 B.H.P. at 2200 r.p.m., is situated to one side of the cab. By raising the front cowling of the cab on the hinges by which it is supported at the top, access is gained to the electrical connections and the radiator elements, while within the cab the bonnet over the engine is in three parts and may be easily lifted off. In order that complete overhauls may be carried out occasionally the cab itself is designed to be removable with very little trouble. For the transmission the combination of a single dry-plate clutch with a "Wilson" pre-selective gear-box giving five forward speeds and a reverse has been chosen.

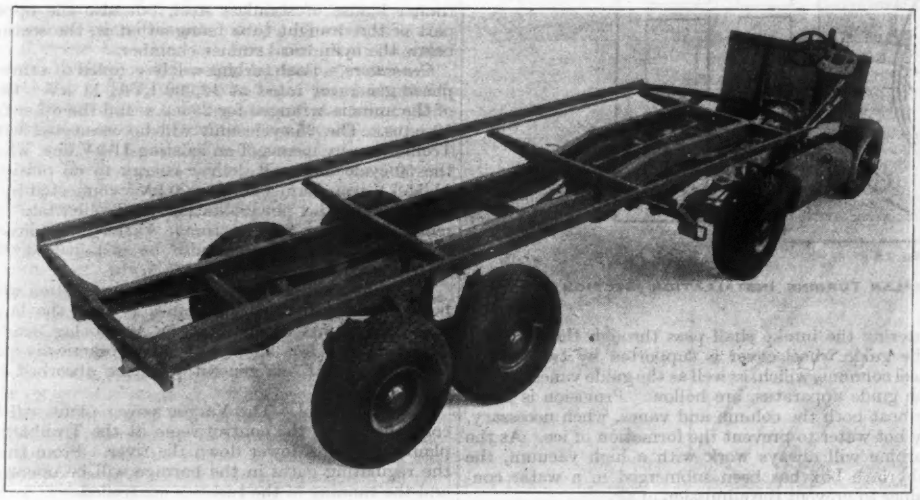


FIG. 28—ARTICULATED EIGHT-WHEEL CHASSIS—SCAMMELL

SCAMMELL LORRIES, LTD.

The name Scammell is particularly associated in the public mind with very large commercial vehicles, and for that reason we propose in dealing with the stand of Scammell Lorries, Ltd., of 52–54, High Holborn, London, to describe the articulated eight-wheeler with a maximum legal gross weight of 22 tons, shown at the Exhibition and illustrated by the engraving, Fig. 28. It is capable of carrying at least 15 tons useful load. This lorry is propelled by either a Scammell four-cylinder petrol engine, with an R.A.C. rating of 40 H.P. or a Gardner six-cylinder oil engine with an R.A.C. rating of 43 H.P. The engine is supported on a three-point rubber suspension.

The lorry has two particularly interesting features. First a six ratio gear-box is fitted, the highest ratio being an overspeed gear to give economical running on flat or down-sloping roads. The gears are of the constant mesh type, and are engaged by sliding dog clutches. Secondly, a novel means of suspension has been adopted for the rear bogie. Two parallel balance beams are pivoted at their centre to each end of a frame cross member, one at each side of the carrier frame. The ends of the balance beams have a pair of long bolts shackled to them. Each pair of bolts passes through and can slide in a trunnion mounted on each of the four axle arms. The trunnion axis coincides with the axis of its respective wheel. Rubber discs are placed between the flat top surface of the trunnion and plates secured to the ends of the long bolts. The two balance beams divide the load between, and allow free movement to, each axle arm.

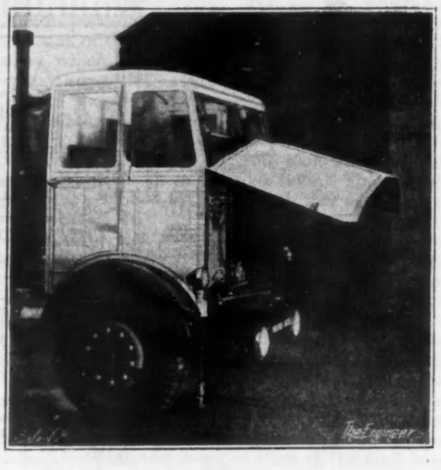


FIG. 29—CAB OF 6-TONNER CHASSIS—YORKSHIRE WAGON

The rubber discs are put under compression by the load and, in conjunction with the large section tires, absorb the road shocks. The balance beams take only the vertical load through the rubber discs and long bolts. All other forces are taken by the axle arms. It will be observed from the photograph reproduced that special attention has been devoted to the design of the frame and bodywork to obtain a light construction.

On the same stand a rigid six-wheeler was also shown and had similar features. The suspension of the bogie, though different in detail, operates on the same principle as that of the articulated vehicle. Specimens of the "mechanical horse" were also shown.

ALBION MOTORS, LTD.

In our issue of November 3rd we dealt with the chassis exhibits of Albion Motors, Ltd., of Scotstoun, Glasgow. Particular interest on this stand centred, however, on the new Albion heavy-oil engine—see Fig. 31—exhibited for the first time in the firm's latest Valkyrie 32/36-seater omnibus service chassis, which is normally fitted with the firm's 35/85 B.H.P. four-cylinder petrol engine. A wider range of operation is now given by the adoption of the heavy-oil engine, which has a bore and stroke of 4in. by 4¾in., and a rated output of from 35 to 70 B.H.P. at a maximum speed of 2200 r.p.m. The direct system of injection is used in conjunction with a C.A.V-Bosch fuel pump. The cylinder and crank case are formed as a single casting of strong proportions, and a feature of the design is the raised cam shaft, which is carried high up on the cylinder block, enabling a form of valve gear—see Fig. 30—very similar to that adopted on the petrol engine to be used. With the oil engine, however, the use of vertical valves has necessitated a slight alteration in the design. As the valves are directly

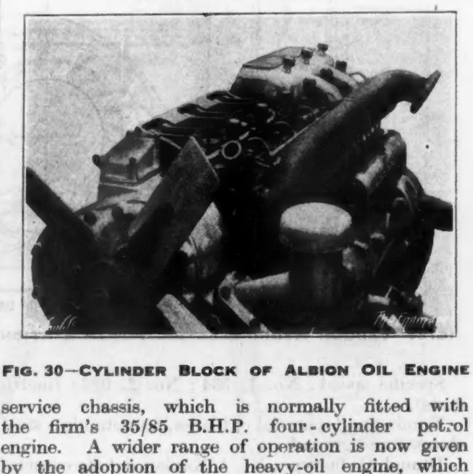


FIG. 30—CYLINDER BLOCK OF ALBION OIL ENGINE

operated from the cam shaft, the whole of the valve gear can be removed for adjustment or repair without altering the timing of the engine. The starting controls embody a neat form of decompression gear. Steel connecting-rods are employed, and special means have been adopted to ensure freedom from bearing trouble. When the new engine has undergone complete tests, it is hoped that further technical details and performance results will be available for publication.

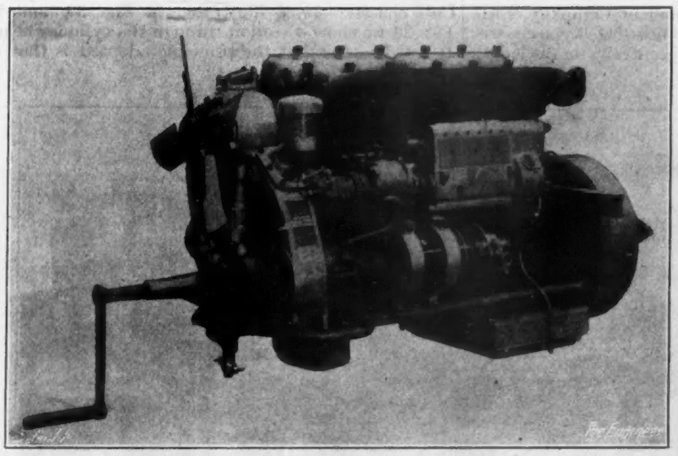


FIG. 31—70 B.H.P. SIX-CYLINDER OIL ENGINE—ALBION

KARRIER MOTORS, LTD.

Two new goods models to be known as the "Falcon" 3-tonner and the "Autocrat" 6-tonner are introduced by Karrier Motors, Ltd., of Huddersfield, for the 1934 programme, but only the first-named was exhibited at Olympia. Carrying a useful load of 3 tons, it has an unladen weight of 38 cwt. Being below the 50-cwt. tax limit, it is enabled legally to operate at 30 m.p.h. The chassis has a wheel base of 10ft. and is mounted on 32in. by 6in. tires. The power unit is a 24/49 H.P. four-cylinder overhead valve petrol engine in unit construction with the clutch and four-speed gear-box and it is mounted in rubber insulation in a frame of the cruciform braced type. Forward control has been adopted. Other models exhibited were the "Protector" 4-tonner, of which the front end has been re-designed and which has been fitted with hydraulic four-wheel brakes; and the "Bantam" 2-tonner, which has been improved in details, but shows little change otherwise except for the mounting of the engine in rubber insulation from the frame.

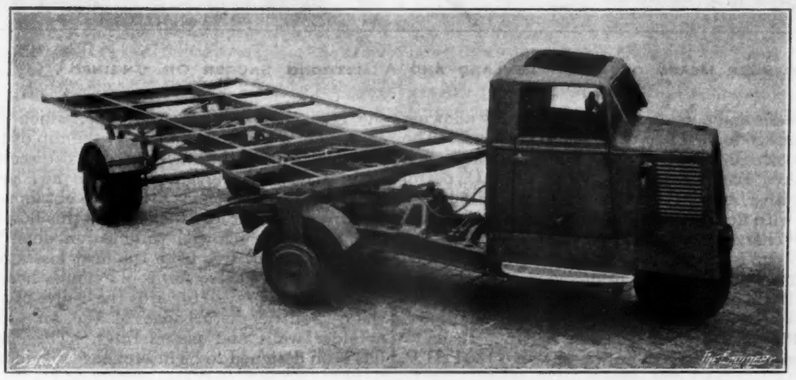


FIG. 32—"COB SIX" 14/52 H.P. THREE-WHEEL TRACTOR—KARRIER

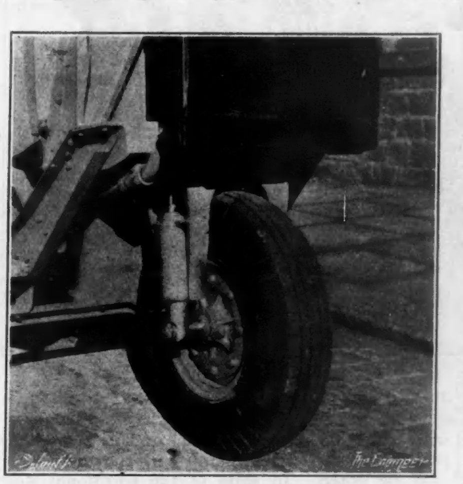


FIG. 33—FRONT SUSPENSION OF "COBS" AND "COLTS"—KARRIER

The effect of the new legislation, it is by no means impossible, will be to further increase the popularity of the three-wheel tractors made by the firm—the "Cobs" and "Colts." There is a newcomer in this range to be known as the "Cob-Six"—see Fig. 32. Whereas the "Cob Major," introduced in 1932, will deal with 4-ton loads on trailers of the quickly detachable type, the "Cob Six" will haul a 6-ton pay load. Its power unit is a six-cylinder 14/52 H.P. engine and it has servo-assisted brakes. In other features it is very similar to its forerunners, all of which have been improved as to the front wheel suspension. The new arrangement is illustrated in Fig. 33 and consists of dual helical springs and plungers instead of the semi-elliptics previously fitted. The steering also has been made lighter by the greater reduction given by the worm and wheel gear. Both "Cob Major" and "Cob-Six" are fitted with the Karrier automatic coupling and brake gear, by means of which trailers are rapidly attached and detached from the tractor without the need for the driver-operator to leave his seat. Furthermore, the trailer brakes, which are operated by means of the tractor hand brake, are automatically coupled when the tractor and trailer are brought together. When a tractor is operating with two or more trailers it is highly probable that the brakes on each trailer will not be adjusted to exactly the same degree, or possibly the brakes of one trailer may be rather more worn than those of the tractor, in which case it will be obvious that a fixed braking system through the tractor would not be efficient. This difficulty has been overcome by the incorporation of a dual braking lay-out, by means of which the direct system employed when the tractor is running solo is quite simply changed over to a compensated one, which is used when the tractor is coupled to a trailer.

In connection with bodywork the firm announces that arrangements are well in hand for the production of bodies built upon light steel underframing, by which means considerable savings in weight are to be effected.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LTD.

The exhibits on the stand of the Bristol Tramways and Carriage Company, Ltd., were principally confined to single and double-deck omnibus chassis of the company's own design and manufacture, which are available either with the firm's own petrol motor or the Gardner heavy oil engine. One of the main exhibits was the "G" type Bristol chassis for a 52-seater, double-deck omnibus which is equipped with the six-cylinder Bristol petrol engine illustrated in Fig. 34. This is a 2000 r.p.m., 103 B.H.P. engine, with an R.A.C. rating of 41 H.P., having a bore of 105 mm. and a stroke of 140 mm. It is complete with C.A.V.-Bosch magneto, starter, and lighting dynamo, and is fitted with syphonic cooling. The engine works in conjunction with a four-speed gear-box with the firm's patented selector gear, and the transmission includes a full floating worm-driven rear axle. The company's cam type spring fittings are used, and there are servo-assisted brakes of the Dewandre type. The tires are high-pressure, 36in. by 8in., and the wheel base is 16ft., the complete weight of the chassis being 4 tons 5 cwt.

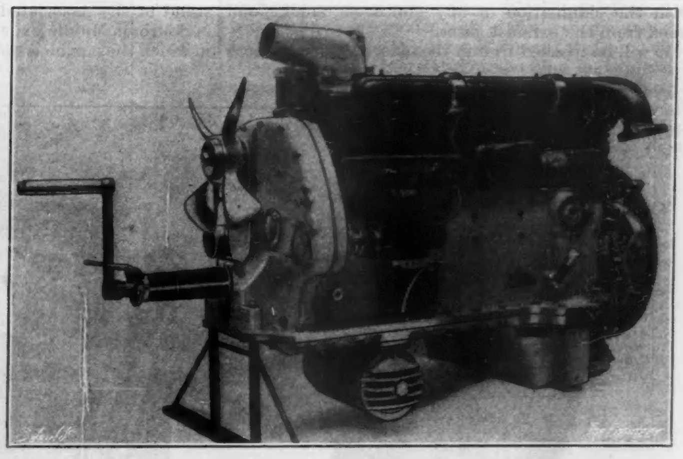


FIG. 34—103 B.H.P. SIX-CYLINDER OIL ENGINE—BRISTOL

Another model is the "J" type Bristol chassis, which was shown equipped with a four-cylinder, 103 B.H.P., Bristol petrol engine and an overspeed gear-box. This model is, however, available with three different petrol engines and an 85 B.H.P. five-cylinder Gardner heavy oil engine. Some fine examples of all-metal omnibus construction were also shown on the stand.

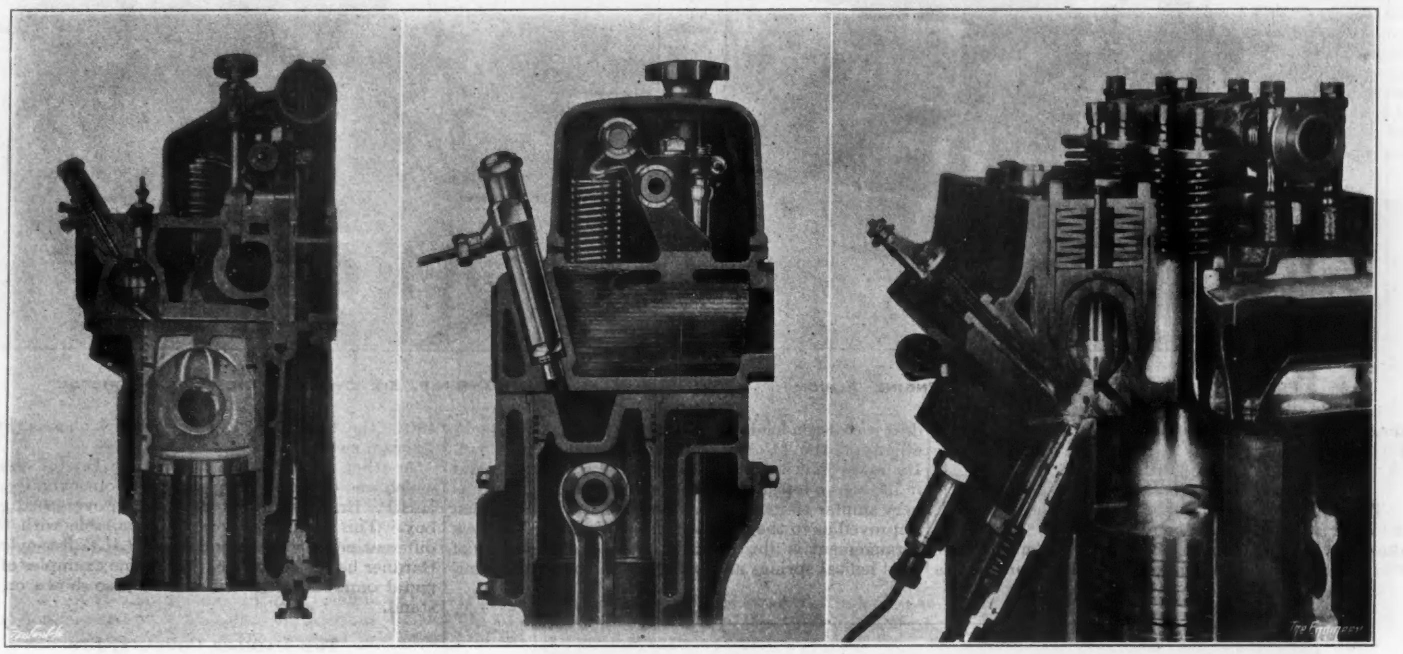
THE DAIMLER COMPANY, LTD.

Prominent on the stand of the Daimler Company, Ltd., of Daimler Works, Coventry, was a large working model of the fluid fly-wheel transmission gear, in which the moving fluid was ingeniously represented by coloured rubber balls circulating within half-couplings of wire mesh. The firm's exhibits were mainly designed to show the advantages gained by the adoption of the fluid fly-wheel transmission in combination with a pre-selective self-changing gear-box. Several double and single-deck omnibus chassis were on view, for which either six-cylinder Daimler poppet valve or sleeve valve engines are available or the Gardner five-cylinder oil engine with a bore of 108 mm. and a stroke of 152·4 mm. and a capacity of 7046 cubic centimetres. This engine, combined with the fluid fly-wheel and a five-speed self-changing gear-box, is claimed to give an absence of difficult gear changing, more economical running, and a higher degree of road safety. The engine can, with this arrangement, be stopped and started at will with the drive engaged and the engine running. Features of the Daimler chassis include a very low frame level with a sturdy and simple construction. The weight of the chassis has also been considerably reduced by the extensive use of high-tensile aluminium alloys, such as are commonly employed in aircraft construction.

ARMSTRONG-SAURER.

On the large stand of Armstrong-Saurer Commercial Vehicles, Ltd., there were exhibited three new oil-engined lorries, which have been specially designed to meet the new system of taxation. They comprise the "Active" and "Effective" four-wheeled models and the "Dynamic" a new six-wheeled vehicle. The principal features of the chassis structure include the use of light steel members and light alloys, which, while maintaining undiminished strength and a high safety margin, have resulted in a very advantageous ratio between the unladen weight and the pay load capacity. Thus in the case of the four-wheeled models the taxation class is 4 to 5 tons and the legal pay load capacity 7 to 8 tons. For the six-wheeled model the taxation class is 7 to 8 tons and the legal pay load capacity 12 tons. All the vehicles can now be arranged for either forward or normal control. In the case of the forward control the engine is placed in the centre of the cab with seats for the driver and his mate, one on either side. Particular attention, we noted, has been paid to the lay-out of the controls, which give a roomy cab, combined with a convenient driving position. A new feature is a sliding roof for the cab, which enables the ventilation to be controlled as may be desired. In fixing the position of the engine the greatest accessibility has been allowed for. Other features of the new chassis are an improved easy steering mechanism, air pressure brakes, and a gearbox giving eight forward speeds. Body lengths up to the legal 24ft. 6in. with forward control are now available. Either the four-cylinder 70 B.H.P. engine or the six-cylinder 110 B.H.P engine can be fitted. Particular interest attaches to the new compensating mechanism in connection with the braking of six-wheeler chassis, which was exhibited on the stand.

A sectioned 110 B.H.P. engine—see Fig. 37—having a bore of 110 mm. and a stroke of 150 mm., shows clearly the cross flow system of fuel injection, which has now been adopted by the company in all its new models, and which, it is stated, has resulted in an increased horse-power of from 10 to 15 per cent. with the elimination of any obnoxious smoke and smell from the exhaust gases.



FIGS. 35, 36 AND 37—SECTIONS THROUGH CYLINDER HEADS OF A.E.C., LEYLAND AND ARMSTRONG SAURER OIL ENGINES

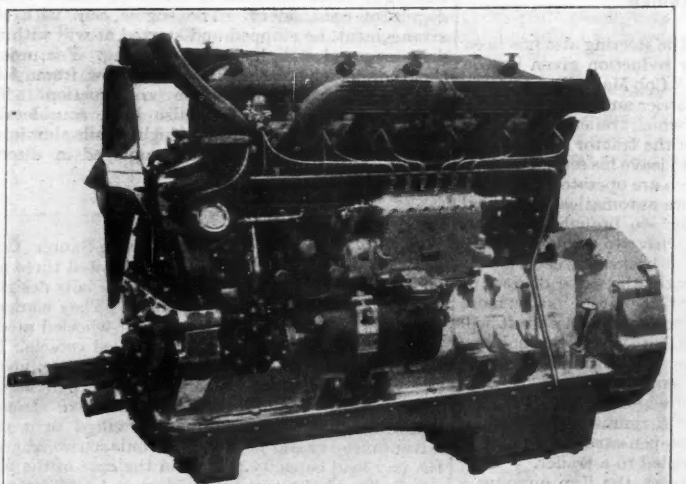


FIG. 38—130 H.P. SIX-CYLINDER OIL ENGINE—A.E.C.

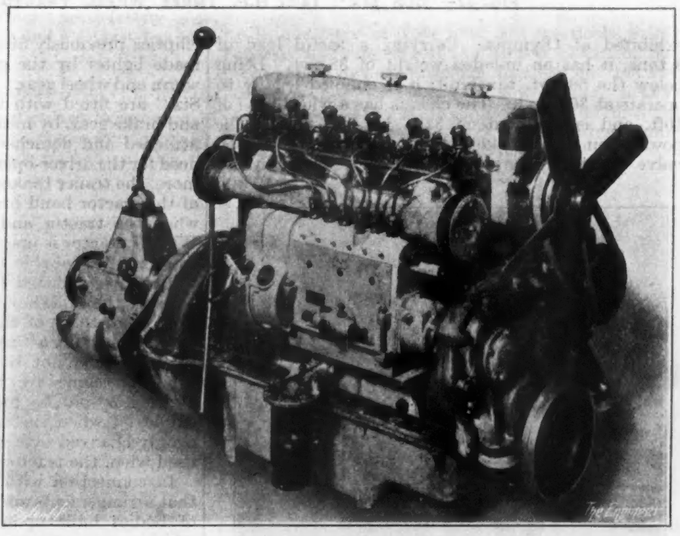


FIG. 39—60 B.H.P. "LIGHT SIX" OIL ENGINE—LEYLAND

It will be recalled that in the older models the Acro system of air cell construction was employed, in which the air during compression was forced through a funnel-shaped opening terminating in a narrow neck connecting with a dome-shaped air cell in the cylinder head. The fuel spray was so directed that it met the turbulent stream of air issuing from the air cell orifice into the combustion chamber, but the relative angle between the injected fuel and the air stream did not permit the fuel to penetrate freely the extreme air particles which had an effect on the available output. In the new Armstrong-Saurer cross flow system, illustrated in Fig. 37, the conditions governing the combustion process are entirely different. The air is now compressed into the air chamber or cell through a long passage which lies at a tangent to the circular lower portion of the domed cell, thereby compelling the air stream to rotate in a predetermined manner, giving an ordered turbulence. The fuel spray is now designed to meet the air current almost at right angles and so to produce a homogeneous mixture of air and fuel particles. By means of the correlation between the timing and duration of the injection period with the swirling air current a thorough saturation of the air with fuel is effected, which, it is claimed, remains constant with varying engine revolutions. It thus becomes quite unnecessary to vary the point of injection with engine speed and the vehicle can be driven with fixed injection timing. The standard Bosch pump and injectors are employed, and our illustration clearly indicates the relative positions of the swirl chamber, the fuel injector and the heating element. The series of corrugated steel washers giving flexible pressure to the top of the domed air chamber may be noted.

THE ASSOCIATED EQUIPMENT COMPANY, LTD.

One of the most interesting of the exhibits on the stand of the Associated Equipment Company, Ltd., of Southall, Middlesex, was the new "Q" type chassis, in which the engine is mounted centrally on the length of the chassis and outside the frame, thereby allowing full advantage to be taken of all the body space. The double-deck omnibus chassis and a long-distance coach shown have 120 B.H.P., 2000 r.p.m., A.E.C. petrol engines with a bore of 110 mm. and a stroke of 130 mm., working with fluid fly-wheel transmission and a four-speed self-changing epicyclic gear-box. A feature of the chassis design is the 11in. by 3in. pressed frame, which sweeps down at the nearside front end in order to facilitate low loading. The goods carrying models included the "Matador" 7½-ton lorry and the "Mammoth Major" 12½-ton light-weight chassis. On the "Regent" type of omnibus chassis there was shown a 130 B.H.P. A.E.C. standard oil engine, Fig. 38. This unit was also to be seen on the Hardy rail car, which was fully described and illustrated in our recent issue of October 27th; while on the A.E.C. stand a sectioned model of the four-cylinder engine attracted much attention—see Fig. 35. Since we described the A.E.C. oil engine at the last Commercial Motor Exhibition progress has been made in its design. The use of special alloys has given lightness of construction combined with maximum strength. We may briefly refer to the Elektron metal crank casing, the special hardened liners and hardened piston rings, and the alloy steels used in the manufacture of many of the important parts of the engine. Special spun copper-lead-bronze is used for the wearing parts of the bearings and has been attended with excellent results.

LEYLAND MOTORS, LTD.

The extension of the heavy-oil engine to the smaller range of commercial vehicles, is well illustrated by the new light-six oil engine designed by Leyland Motors, Ltd., of Leyland, Lancashire, and Kingston-on-Thames, for the well-known Leyland Cub chassis. It is illustrated in Fig. 39, and in Fig. 36 we show a section through the cylinder head. It will be seen that the principle adopted is that of the Leyland direct-injection type, which essentially consists of a simple open cup in the top of the piston towards which the fuel spray is directed. The natural upward movement of the air, as it enters the combustion space, is utilised to obtain a thorough mixture of the air and fuel, and as this flow is orderly and non-reversing, the combustion chamber shape is claimed to be free from the heat losses of some of the more complicated forms of cylinder head. Again, as the fuel is sprayed towards the centre of the piston, there is little disturbance of the oil film on the cylinder walls and piston rings. The engine itself has been designed to be interchangeable in the chassis with the Cub petrol engine, and the very neat positioning of the fuel pump unit shown in Fig. 39 may be noted. In spite of the additional weight of the fuel pump and the more robust electrical equipment, the complete engine only weighs 850 lb., and it occupies no more space in the chassis than does the six-cylinder petrol engine.

It has six cylinders, each with a bore of 3⅜in. by 5in., the displacement being 268·4 cubic feet, or about 4·4 litres. It is designed to develop 28 B.H.P. at 1000 r.p.m., and 60 B.H.P. at its governed speed of 2400 r.p.m. We were permitted to make an extended trial run in Surrey on one of the "Cub" goods vehicles fitted with the new engine, and found it to be exceptionally smooth and quiet in its running throughout its speed range. It started up easily, without the use of electrically heated glow plugs or other auxiliary apparatus, and on hills it exhibited that reserve of power which is peculiar to the oil engine as compared with the petrol motor. Some constructional features of the new engine include a monoblock cylinder casing and crank case, which is fitted with centrifugally cast cylinder liners of special quality metal. The pistons are made of heat-treated aluminium alloy, and each carries three compression rings and an oil scraper ring. The connecting-rods are also made in aluminium alloy, which is heat treated, and a further interesting feature of the design is the fact that bottom end bearing shells are done away with and the aluminium alloy is run in direct contact with the hardened surface of the crank pin. The fuel injection gear is of the C.A.V.-Bosch pattern with single-hole sprayers. The lubricating oil system is generally similar to that employed on petrol engines, and it includes a fabric type oil filter. Air filters are fitted to each end of the intake manifold, and the starting equipment consists of a 24-volt C.A.V.-Bosch starting motor with a dynamo for lighting. The engine we have described is a notable addition to recent heavy-oil engines.

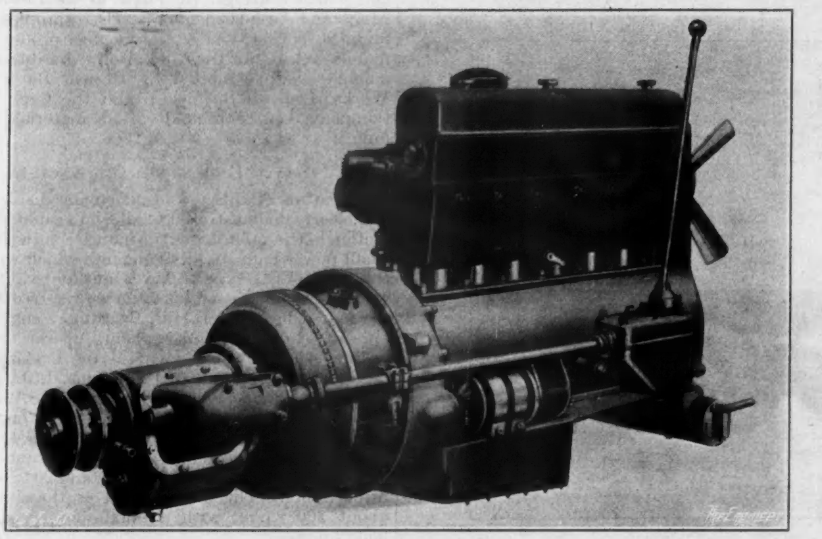


FIG. 40—110 B.H.P. PETROL ENGINE AND TORQUE CONVERTER—LEYLAND

Any description of the Leyland stand would not be complete without a reference to the Leyland hydraulic torque converter, working on the Lysholm-Smith principle, which was shown as a unit construction in combination with a six-cylinder 110 B.H.P., 2200 r.p.m. petrol engine, installed in a 26-seater "Tiger" luxury coach. The complete unit is shown in Fig. 40. For a full description our readers may be referred to our issue of October 13th, 1933.

THE SENTINEL WAGGON WORKS, LTD.

Much interest centred around the vehicles shown on the stand of the Sentinel Waggon Works, Ltd., of Shrewsbury, and London, these being, to the best of our knowledge, the only steam-operated vehicles shown at Olympia. They included the smaller 6 to 7-ton four-wheeled models shown with plain and hydraulically operated tipping bodies, one of these models being fitted with the firm's latest automatic stoker and feed water regulating apparatus. The 10 to 12-ton models were also on view, but we have chosen for illustration the new eight-wheeled vehicle for 13-ton legal loads shown in Fig. 41. This is interesting, not only on account of the very neat engine, boiler, and cabin lay-out which has been provided, but also because of the novel four-wheel steering device, illustrated in Fig. 42. As the engraving shows, there are two drop forged steel axles carrying wheels at either end. These are connected to the ends of strong flexible springs, the central bearings of which pivot on the cross members of the brackets, which in turn are attached to the frame of the chassis. The main axle wheel base is 14ft. 4¾in. and the front bogie centres 3ft. 5½in., those of the rear bogie being 4ft. with a 6ft. 4¾in. track. The front wheels carry single 36in. by 7in. tires and the rear wheels 38in. by 8in. twin tires, all of which are of the detachable disc pattern. With a 20ft. long flat platform type body and cab the chassis weight is 7 tons. The power unit is the new glandless four-cylinder single-acting non-compound steam engine, which has a bore of 5½in., a stroke of 6in., and is designed to develop 120 B.H.P. when supplied with steam at 225 lb. pressure. The boiler is of the firm's latest large-tube type and is arranged for hand firing, the fuel compartments being so contrived as to give a gravity feed. The engine cam shaft is designed for three forward and one reverse cut-off positions. There is a unit construction type of two-speed gear-box and the transmission is by a Hardy-Spicer cardan shaft drive to the four-wheel rear bogie through double reduction gears, the drive being from spiral bevel gear to double helical gear. Both the front and the rear bogies are fully compensated, there being front all-wheel steering, as already mentioned, with rear braking and torque reaction on the Hotchkiss system. On the stand there were shown the principal constructional parts of the engine and the transmission drive, and we were impressed by the evident care which has been taken in simplifying the design of the steam engine and boiler, the engine construction having been carried through on lines not far removed from those of standard oil engine practice. It is of interest to record that the 120 B.H.P. engine weighs barely 9 cwt.

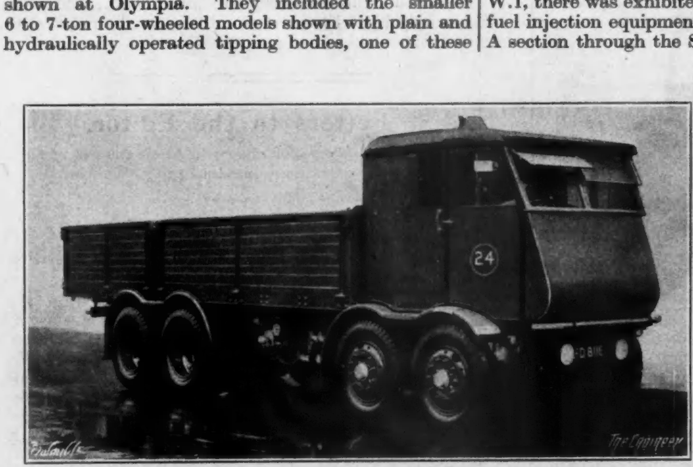


FIG. 41—RIGID EIGHT-WHEELER STEAM WAGON—SENTINEL

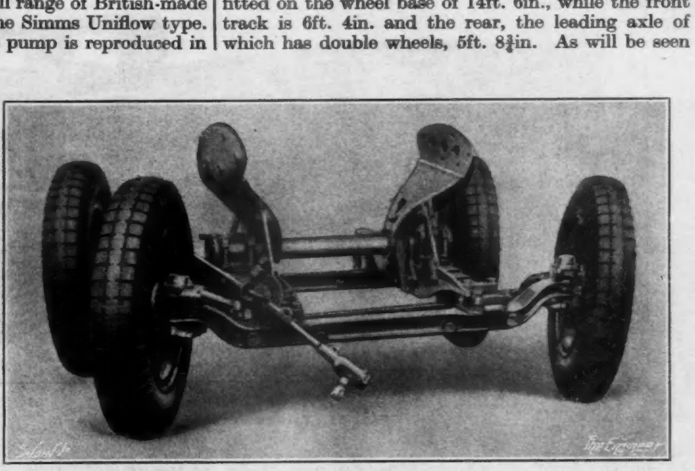


FIG. 42—FRONT STEERING BOGIE OF STEAM WAGON—SENTINEL

SIMMS MOTOR UNITS, LTD.

On the stand of Simms Motor Units, Ltd., of Percy Buildings, Gresse-street, Rathbone-place, London, W.1, there was exhibited a full range of British-made fuel injection equipment of the Simms Uniflow type. A section through the Simms pump is reproduced in Fig. 43. Assuming the pump to be filled with oil and the plunger near to the end of its stroke, as shown in the drawing, the upward movement of the plunger compresses the oil and delivers it through the spring-loaded valve into the pipe leading to the injection nozzle. If in response to governor or hand control an earlier cut-off is required, the plunger is slightly rotated by a rack motion, which at a pre-determined point in the plunger stroke brings the helix cut in the plunger into coincidence with the helical edge of the port cut in the upper end of the barrel. When this takes place the oil under pressure spills into the helical channel of the plunger and is ejected tangentially at high velocity into the spill annulus, rejoining the entry stream in the suction inlet pipe and part of it passing with this downward suction stroke through the suction ports and the suction annuli into the working chamber. The direction of flow of the oil through the suction ports is always the same, namely, in an upward direction, giving a uniflow system of operation. On the stand an electrically operated model with a stroboscopic arrangement of lighting clearly demonstrated the form of oil spray obtained with the Simms pump and injection nozzle. The pumps are available as single-flanged units without cams or complete self-contained single or multi-cylinder units with or without injection timing controls or governors. The sizes available are 6 mm. and 7 mm. bore with strokes of 7·5 mm. and 8 mm. and 10 mm. and 11 mm. bore with a stroke of 10 mm. For use in connection with the Simms fuel injection equipment the firm has recently introduced a new simple form of self-cleaning filter for fuel oil and other industrial uses, which was also exhibited on the stand.

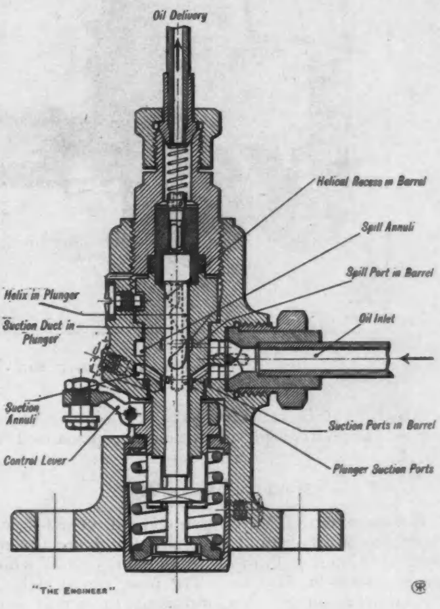


FIG. 43—FUEL PUMP—SIMMS

PAGEFIELD COMMERCIAL VEHICLES, LTD.

On the stand taken by Walker Brothers (Wigan), Ltd., of 40/42, Quadrant House, Pall Mall, London, there was to be seen a new 7-ton light rigid six-wheeled lorry known as the "Pegasix," designed by Pagefield Commercial Vehicles, Ltd., of Pall Mall, London. This lorry is propelled by a Gardner 5 L W oil engine, developing 85 B.H.P. at 1550 r.p.m., which is suspended in the frame by silentbloc bushes. The main frame of the vehicle is of 10in. channel section pressed steel, and the whole design is light and flexible, while, at the same time, amply strong. A platform, 16ft. 6in. or 19ft. 2in. in length, may be fitted on the wheel base of 14ft. 6in., while the front track is 6ft. 4in. and the rear, the leading axle of which has double wheels, 5ft. 8¾in. As will be seen from the engraving, Fig. 44, forward control has been adopted, and the front axle is set back. The turning circle is between 54ft. and 58ft. Four forward speeds and reverse are provided by the gear-box, which is in unit construction with the engine. All the gears are ground, on their splines, to accurate tooth profile after hardening. Self-energising brakes of the Bendix-Perrot duo-servo type, acting on all the wheels and operated either by foot or by hand, provide for the safety of the vehicle on the road. The whole lorry has been designed to permit of easy maintenance, and with this point in view accessibility has been carefully studied. At the same time, the unladen weight has been kept as low as possible consistent with safety. Complete with its cab, platform, and engine, it weighs 4 tons 17 cwt., and the fuel consumption, according to the makers, works out at 130 ton-miles per gallon. The actual lorry exhibited at Olympia had a large van body, but in other respects was similar to the vehicle, a photograph of which is reproduced in Fig. 44.

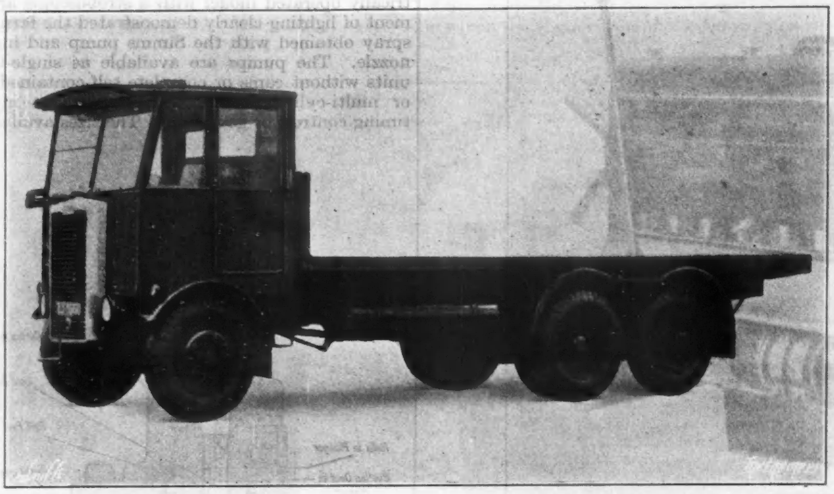


FIG. 44—LIGHT SIX-WHEEL LORRY—PAGEFIELD

MORRIS-COMMERCIAL.

A wide range of Morris-Commercial vehicles was displayed on the stand of Morris Commercial Cars, Ltd., of Adderley Park, Birmingham, one of which we illustrate in Fig. 45. The new range includes 30-cwt. to 3-ton vehicles, and also 3½-ton and 5-ton models, all of which embody special new features derived from the firm's extensive road experience. Four and six-cylinder engines are available with either normal or forward controls. The new design of chassis is specially strengthened with triangulated frame bracing, which, it is claimed, doubles the strength at the most important sections. The springing is special in that the springs are progressive and automatically vary the suspension according to the load which they are called upon to deal with. Lockheed hydraulic brakes are fitted to each of the four wheels and the gear-box is of the four-speed, silent, twin-top pattern. One of the largest vehicles was a double-deck omnibus chassis known as the "Imperial," which is equipped with a six-cylinder, 110 B.H.P. engine, a feature of which is the high arrangement of the cam shaft and the particular design which enables the power unit to be wheeled out on the front axles when repairs or adjustment are required.

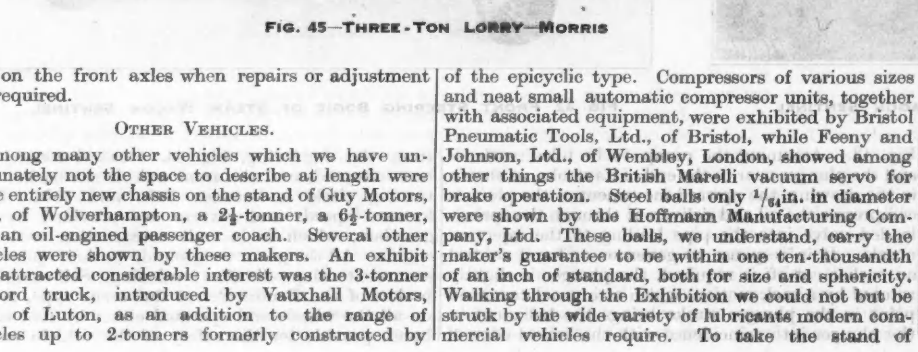


FIG. 45—THREE-TON LORRY—MORRIS

OTHER VEHICLES.

Among many other vehicles which we have unfortunately not the space to describe at length were three entirely new chassis on the stand of Guy Motors, Ltd., of Wolverhampton, a 2½-tonner, a 6½-tonner, and an oil-engined passenger coach. Several other vehicles were shown by these makers. An exhibit that attracted considerable interest was the 3-tonner Bedford truck, introduced by Vauxhall Motors, Ltd., of Luton, as an addition to the range of vehicles up to 2-tonners formerly constructed by the firm. Tankers of various types were shown by the Steel Barrel Company, Ltd., of Uxbridge, and Carrimore, Ltd., of North Finchley, London, showed two trailers, one a 5/6-ton and the other an 8-ton, besides six-wheeler attachments. An attractive vehicle was the 350/450-gallons per minute motor fire engine, exhibited by Halley Motors, Ltd., of Yoker, Glasgow. The fire pump is mounted at the rear of this machine, and is fitted with two delivery valves and a 4in. suction inlet. It is driven through a chain from an auxiliary gear-box in the chassis transmission line. Several other vehicles were exhibited by this firm. Fodens, Ltd., of Sandbach, Cheshire, exhibited a number of oil engine driven vehicles, and the novel bogie suspension system on the stand of Longframe Six-wheeler Construction Company, of Copenhagen, attracted considerable attention. There were a number of interesting exhibits on the stand of the Truck and Tractor Appliance Company (Manchester), Ltd., of which we may mention the twin-spring suspension arrangement, one spring above and the other below the axle, and the neat "pick-up" gear for the attachment of a semi-trailer.

ACCESSORY AND DETAILS.

A large amount of space in the Exhibition was taken by the makers of accessories and of garage equipment, &c. Among the firms showing such productions, David Brown and Sons (Huddersfield), Ltd., exhibited gears of all types and hobs and cutters for their manufacture; in addition, there was to be seen on the stand a new type of "Roots" supercharger. The grinding of gears was represented by the Gear Grinding Company, Ltd., of Handsworth, Birmingham, which exhibited specimens of ground gears, the involute gear-testing machine we described some months ago, and the parts of pre-selective gear-boxes of the epicyclic type. Compressors of various sizes and neat small automatic compressor units, together with associated equipment, were exhibited by Bristol Pneumatic Tools, Ltd., of Bristol, while Feeny and Johnson, Ltd., of Wembley, London, showed among other things the British Marelli vacuum servo for brake operation. Steel balls only $^1/_{64}$in. in diameter were shown by the Hoffmann Manufacturing Company, Ltd. These balls, we understand, carry the maker's guarantee to be within one ten-thousandth of an inch of standard, both for size and sphericity. Walking through the Exhibition we could not but be struck by the wide variety of lubricants modern commercial vehicles require. To take the stand of Sternol, Ltd., as an example, there were shown eight different types of oil, not to mention the various grades in each type and the range of greases. All kinds of fittings for commercial vehicles were shown by the A.C.-Sphinx Sparking Plug Company, Ltd., of Birmingham, including, of course, sparking plugs, oil gauges, petrol gauges, speedometers, whilst clocks, &c., were also to be seen. The Skefko Ball Bearing Company, Ltd., showed the range of products, ball and roller bearings, produced in its Luton works. Alloy and case-hardening steels, examples of drop forgings, spring steel, stainless steel products, automobile axles and the "Johnson" hardness testing machine were exhibited by Brown, Bayley's Steel Works, Ltd., of Sheffield; and the Cape Asbestos Company, Ltd., exhibited various materials for brake linings.

SMALL HIGH-SPEED OIL ENGINES.

A feature of this year's oil engine display, which was clearly demonstrated to all who visited the engine section in the gallery, was the increase in the number of small power high-speed oil engines, which will extend the range of this type of power unit for road transport work. In our last week's issue we referred briefly to the four-cylinder 45 B.H.P. Beardmore engine with a bore of 3½in. and stroke of 5in., operating at 2400 r.p.m. Another small engine is the Perkins car size motor, manufactured by F. Perkins, Ltd., of Peterborough and 55, Pall Mall, London, S.W.1. This firm supplies three models with bores of 3in., 3·15in., and 3·35in. with a common stroke of 4¾in., with designed power outputs over a speed range of 1000 to 3000 r.p.m. of 16 to 40, 18 to 45, and 20 to 48 B.H.P. respectively. The idling speed of these engines is about 300 r.p.m. with a maximum speed of over 3500 r.p.m.

Another small engine, Fig. 46, was shown on the stand of J. and H. McLaren, Ltd., of Midland Engine Works, Leeds, which firm exhibited a four-cylinder unit having an output of 36 to 50 B.H.P. over a speed range of 2000 to 3000 r.p.m. The model referred to is a short-stroke engine, which has the advantage of a low piston speed at high revolutions, a piston speed of 1650ft. per minute being attained at 2500 r.p.m. The complete engine with its fly-wheel, exhaust manifold and electrical equipment only weighs 700 lb., and with specially light Electron metal this can be reduced to 600 lb.

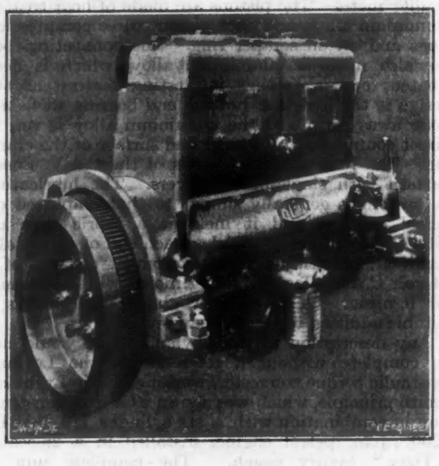


FIG. 46—50 H.P. OIL ENGINE—MCLAREN

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

WATER LOWERING IN QUICKSANDS.

SIR,—Mr. T. L. Reed Cooper's letter in your issue of November 3rd and that of "Waterworks Engineer" are not without interest.

Those who attended Sir Henry Japp's paper, or who read it carefully in your columns, will recognise that Mr. Reed Cooper's generalities give an erroneous presentation of the case, and it is to be regretted that he did not participate in the discussion, which was promoted for the very purpose of enabling persons interested to express their views and to give the reader of the paper opportunity to answer any detailed criticism.

It is not fear, but partly financial considerations, which prevent such systems as ground water lowering developing first in this country. New systems naturally develop where existing conditions create the urge or give the greatest opportunity. This was the case in the development of shield-driven tunnels in this country and of heavy excavating machinery in the U.S.A.

The geological conditions in North Germany and the Low Countries are such that a great and continual need exists for the evolution of means to deal with water-bearing grounds. In the case of the process of ground water lowering by deep-well pumps in filter wells, engineers, contractors, and pump manufacturers were all embodied in one very efficient organisation, which could handle the long and costly evolution of the system which has given such satisfactory results.

British conditions in carrying out large contracts do not lend themselves readily to organised gradual development of new methods.

That we should benefit by German experience is no more lamentable than the fact that a British firm built shield-driven tunnels under the rivers of New York.

Mr. Reed Cooper's submersible pumps are well known, and his patents for bore-hole pumps can be studied in the Patent Office Library, but it would be interesting to know whether really suitable pumps of tried reliability and in sufficiently large numbers were available for immediate use at the time the works described in the paper had to be put in hand.

If "Waterworks Engineer" were to read the paper more closely he would see that "unwarranted claims of novelty" were not made and his whole letter seems based on misconceptions.

It is to be hoped that, on mature considerations, he regrets having made an uncalled-for attack under a pen-name upon the Southern Railway and their engineers. This company by its bold undertakings at Southampton, has done so much to create employment and ensured a wide scope for British plant. Their engineers have been engaged upon works of great importance and serious responsibility, and they expressed their appreciation of having been able to avail themselves, in time of urgent need, of the experience of those who were in a position to offer, not advice, but immediate skilled assistance and equipment of proved dependability.

H. J. B. HARDING.

London, S.W.15, November 13th.

SIR,—In 1838 Robert Stephenson by forming a cone of depletion through water-logged sand was able to construct the Kilsby Tunnel ("Proc.," Inst. C.E., Vol. CXXXIV., pages 255, 256, Dawkins on "The Relation of Geology to Engineering").

In a description of Ransome's artificial stone (1873) it is stated that the chemicals used were silicate of soda and chloride of calcium. The base was finely sifted sand, to which a small proportion of pulverised stone was added to give the silicate and lime, produced in the manufacture, the necessary closeness of surface for its cementing action.

The report states that the chloride of calcium acts rapidly on the silicate of soda and solidifies the mass.

J. M. LACEY.

London, N.W.8, November 8th.

Modern Trends in Railway Motive Power.*

THE subject which we are to discuss to-night has to do with trends of railway motive power: trends in design, in performance, and in thought. Motive power characteristics depend to a large degree upon the conditions surrounding railway operation. During the past five years we have seen marked changes in these conditions and in the demands for railway service.

Shippers' requirements along with highway competition have forced railway management to alter the character of service given to the public for many years. Huge inventories are no longer necessary; hand-to-mouth buying is the order of the day. Deliveries of materials for manufacturing purposes are now made with sufficient dispatch to ensure prompt completion of finished product. Overnight shipments are now accomplished where days were formerly needed, so that even under the adverse business conditions existing for the past three or four years we find definite departures from previously accepted standards in railway operation, and this is reflected in the design of the motive power that performs the service.

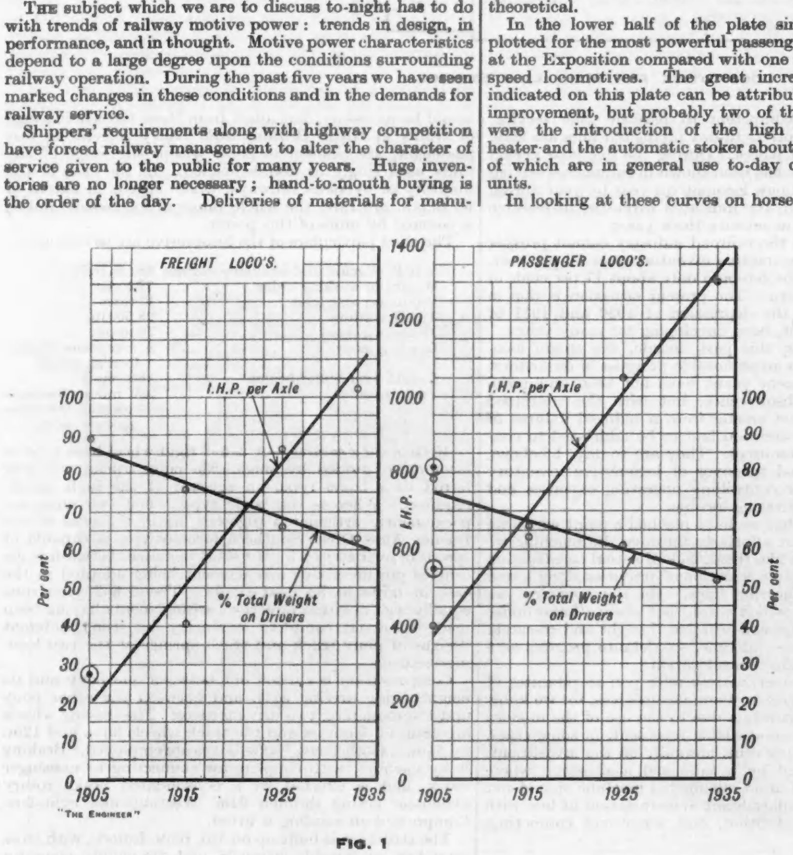


FIG. 1

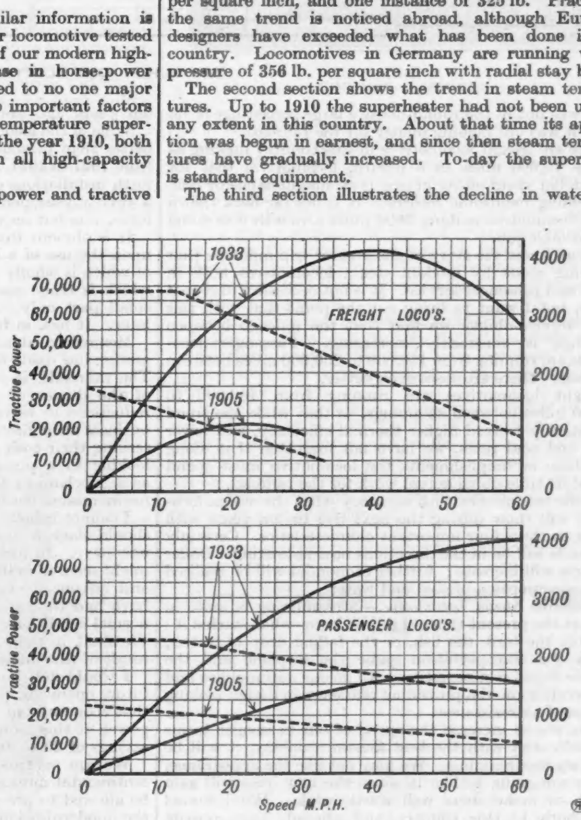


FIG. 2

Steam Locomotive—Indicated Horse-power—Weight Characteristics.—Fig. 1 shows the general trend based upon actual test figures of representative locomotives as to indicated horse-power per axle and percentage of weight on drivers. It does not represent maximum performance entirely—it does show tendencies.

You will observe that freight locomotives averaged about 250 horse-power per axle in the early 1900's, and that to-day we are exceeding 1000 horse-power per axle. Also observe that at the earlier date the percentage of weight on drivers was around 87, while to-day it is approximately 60.

There is a reason for this. As we all know, the freight service of 1905 was slow. Freight locomotives were designed to haul maximum tonnage at low speed. To-day, we still have a limited amount of freight handled in the same manner, but for the past few years the tendency has been toward higher speeds in this service. Since 1923 only the average speed of freight trains in this country has increased 42 per cent. Some of our freight schedules are nearly as fast as those of our passenger trains. This calls for revised ideas as to the characteristics of the freight locomotive. We must have adequate starting tractive effort, but equally important is the capacity of the boiler to maintain these schedules at high speeds. Without increasing to a prohibitive figure individual weight on driving wheels, this enlarged boiler capacity must be carried on trucks.

Individual driving wheel loads have increased materially since 1905, but not to the same percentage as the increase in horse-power. The average weight per driving axle of the freight locomotives tested at the St. Louis Exposition was about 43,000 lb. To-day, it might be considered as being around 60,000 lb. to 65,000 lb., or perhaps a 50 per cent. increase. The horse-power per axle, as you will see from the trend line, has increased during this time close to 300 per cent.

On the other side of the plate you will note that a similar condition exists as to passenger locomotives. The trend line shows an average of about 300 to 400 horse-power per axle in the early 1900's, and to-day we are exceeding 1200 horse-power per axle; likewise, the percentage of weight on driving wheels to total weight is decreased from approximately 75 per cent. to about 55 per cent.

Here I would call your attention to the influence of the "Atlantic" type locomotive as early as 1905. The large circles shown outside of the trend line indicate its relation to the averages of other classes. It had a low percentage of its weight on driving wheels and a correspondingly high boiler capacity. On account of the relatively small number of locomotives of this type in important service to-day, the trend lines have been developed without taking their effect into consideration.

Steam Locomotive—Tractive Power—Indicated Horse-power—Speed Characteristics.—In the upper part of Fig. 2 you will note in full lines the horse-power characteristics of two freight locomotives; in dotted lines, the tractive power characteristics of the same locomotives. The lower lines show the capacity of a "Consolidation" locomotive of 1905; the upper lines represent a modern high-speed freight locomotive with the same number of driving axles. These are actual test curves, not theoretical.

In the lower half of the plate similar information is plotted for the most powerful passenger locomotive tested at the Exposition compared with one of our modern high-speed locomotives. The great increase in horse-power indicated on this plate can be attributed to no one major improvement, but probably two of the important factors were the introduction of the high temperature superheater and the automatic stoker about the year 1910, both of which are in general use to-day on all high-capacity units.

In looking at these curves on horse-power and tractive power characteristics, please bear in mind that the old measuring stick of tractive power does not apply with the force to-day that it did in 1905. At that time the measure of railroad operation was ton-miles; to-day it is ton-miles per hour. Tractive power does not produce ton-miles per hour; horse-power does.

The average tractive power of the most modern fast freight locomotives may be considered at 60,000 lb. to 65,000 lb., or an increase of perhaps 75 per cent. above the "Consolidation" locomotive of 1905 that I have referred to. The horse-power increase, however, is over 250 per cent.

You will find that one of the principal factors in the great improvement in gross ton-miles per train hour is the use of modern high wheel, high horse-power, high-speed freight locomotives—locomotives that have sufficient tractive power to move the tonnage required, but also what their predecessors do not have—sufficient lung power or boiler capacity to give and maintain the horse-power required to perform this service.

Steam Characteristics.—In Fig. 3 we have in diagrammatic form an illustration of the trends from 1905 to the present day in connection with steam characteristics. The first section of the diagram gives you the trend in boiler pressures. I might say at this point that this line is based only on the conventional type of radial stay boiler and does not include anything but simple locomotives. You will note that for several years a boiler pressure of around 200 lb. per square inch was practically standard.

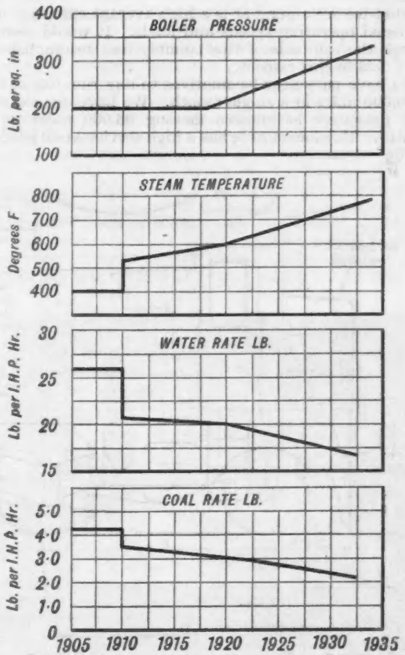


FIG. 3

Along about 1920 the tendency was to increase the pressures, and that tendency has continued until we have a number of locomotives to-day running at 300 lb. pressure per square inch, and one instance of 325 lb. Practically the same trend is noticed abroad, although European designers have exceeded what has been done in this country. Locomotives in Germany are running with a pressure of 356 lb. per square inch with radial stay boilers.

The second section shows the trend in steam temperatures. Up to 1910 the superheater had not been used to any extent in this country. About that time its application was begun in earnest, and since then steam temperatures have gradually increased. To-day the superheater is standard equipment.

The third section illustrates the decline in water rate in pounds per indicated horse-power hour, and the fourth section, the decline in the coal rate. For the saturated steam period up to 1910 these lines have been plotted based upon the averages obtained on the simple locomotives tested at St. Louis.

No trend line is shown for thermal efficiency. It is difficult to do this without opening the door to considerable argument. Steam locomotive thermal efficiencies have increased materially during the past few years up to a maximum of about 14½ per cent. in the condensing locomotive. Thermal efficiency, however, is not the only measure of locomotive performance. A maximum thermal efficiency may be obtained under certain conditions that do not represent the average which the locomotive meets in everyday operation. Thermal efficiency does indicate the possibilities of a design, but its measure should be taken under the conditions which the locomotive has to meet during most of its working time.

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* From a lecture delivered to the New York Railway Club by Mr. William C. Dickerman, President of the American Locomotive Company, Ltd.

In too many cases maximum thermal efficiencies reported are taken at speeds which do not occur but for a small percentage of the time. Of equal importance is what I might call the service-ability factor. One locomotive giving a high peak thermal efficiency, but very expensive in first cost and unreliable in operation because of its high maintenance, does not make the money for the railroad that another locomotive does with a lower thermal efficiency and with a reasonable first cost, simple in design, low in maintenance, and having a high service-ability factor.

What we are aiming at is a high average efficiency over the usual operating speeds and loads. It would seem as though the railroads of this country had accomplished a great deal in this respect.

We have passenger locomotives to-day running as high as 20,000 miles in a single month. We have one example of a passenger locomotive making 96,000 miles in six months. This locomotive has a high service-ability factor, and it was not in the round-house a large percentage of its time ; it was out making money for the railroad.

There are freight locomotives in this country making as high as 10,000 miles in a month, locomotives that for every dollar spent either in first cost, maintenance or fuel, are yielding handsome returns. It is not far back that a freight locomotive making 3000 miles a month was doing a remarkable job.

You all know the story of the greater trip mileages that are being made by modern steam locomotives both in freight and passenger service. It is not necessary to repeat it here, but I want to bring out the point that with this higher service-ability we find that the mileage between shoppings is constantly increasing. Passenger locomotives are running from 150,000 to 200,000 miles between shoppings—there are cases even better.

Freight locomotives are running from 100,000 to 150,000 miles between shoppings, so that while the trend is constantly toward higher thermal efficiency, and lower steam and coal rates, we have not forgotten that along with these accomplishments the locomotive must spend most of its time doing actual work for the railroad.

No one can predict with accuracy what the steam locomotive will show during the next five to ten years with respect to these four important characteristics. Certainly the trends will be in the directions now indicating. Boiler pressures will increase ; further economies will be realised in the consumption of coal and water.

Streamline Steam Locomotive.—Streamlining is quite in vogue at the present time. I do not know what started it ; probably the bird, the fish, or the falling drop of water ; but in the transportation game the airplane and the dirigible found it a necessity. All of our automobiles and water craft show the prevailing tendency in design looking to reduced air resistance.

If we are to increase the speed of our passenger trains materially and with the best known economy, it will be necessary to streamline. We may not like the appearance, but we are going to like it, since the new lines will gain enough to make them well worth while. Wind tunnel tests, both in this country and abroad, have proven definitely that a streamlined locomotive and train, with proper vestibule connections between cars, and some attention to rear end air currents, will reduce the wind resistance by 20 to 30 per cent.

This is an extremely important item, since it has been demonstrated that an automobile travelling at 60 miles an hour meets with air resistance several times greater than the resistance to forward progress set up by contact of wheels and roadway. It can be shown, too, that reduced air resistance is directly proportional to the degree of streamlining provided.

Here, then, we can readily see a means of reducing the horse-power required to attain high speeds. It is calculated, and I think with a high degree of accuracy, that one of our high-speed passenger locomotives running at 80 miles an hour requires 200 to 300 more horse-power than it would if it were streamlined.

Conclusion.—By way of conclusion, then, it is only meet that I mention the unduly high expense at present revolving around the use of the largest single element in the cost of producing railroad transportation.

Motive power expenses have been unusually high during the past seven or eight years for several reasons. First, the cost of maintenance, per unit of work done by the locomotive, increases steadily with advanced age. Secondly, the thermal efficiency of the modern locomotive has been so greatly improved over that of the power units built prior to ten years ago that large fuel economies are now obtainable by the use of new locomotives, as compared with those now experienced with the existing inventory. And, finally, the character of traffic, particularly freight traffic, has changed radically in the past ten to fifteen years. There is a large and growing demand for high-speed freight service—quite aside from passenger service—which can be met economically and effectively only with motive power having adequate boiler and engine capacity and large driving wheels, all designed to pull heavy loads at high speeds.

Practically none of the locomotives built more than ten years ago are competent to perform this service.

Some of the locomotives to-day plying our lines are little better than museum pieces. During the five-year period from 1927 to 1931, as has been shown in summaries setting forth installations of new locomotives year by year during a twenty-year period, the indicated turnover, in tractive force, was but once in seventy-three years.

It is obvious that the railroad industry cannot prosper upon the use of a locomotive inventory over 50 per cent. of which is wholly obsolete and only about 17 per cent. of which is truly modern. The present situation is due in small part only to the depression of 1930 and 1931 or later. It has, in fact, been developing for many years.

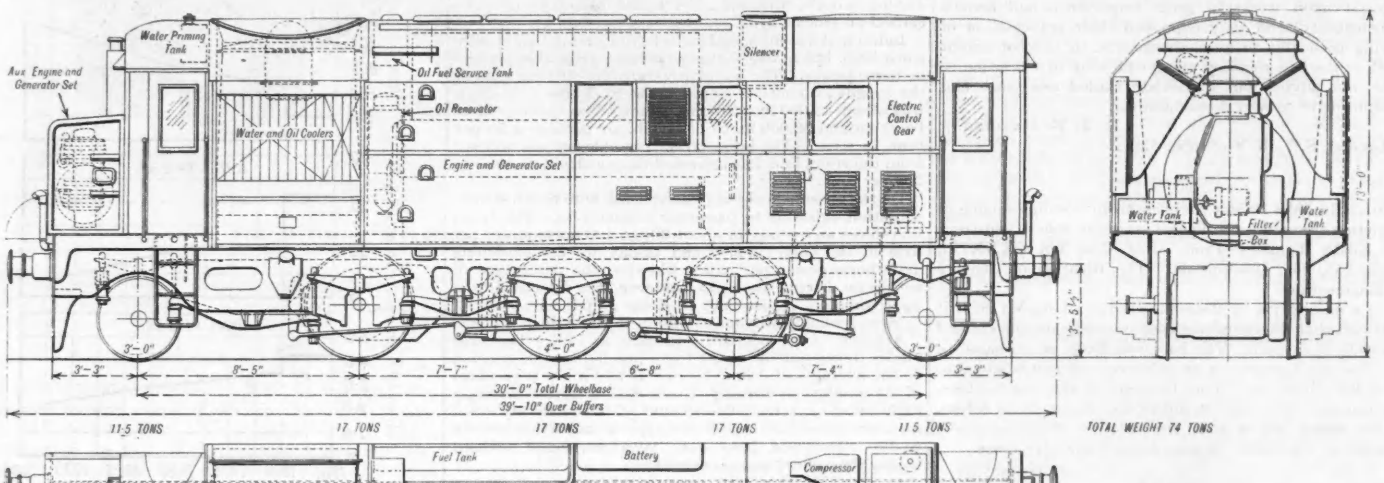
Meanwhile, during this past decade, the steam locomotive has made the most notable progress in its history. The railroads, in recent years, have not been unmindful of the degree of obsolescence, but with the continued reductions in revenue arising from a reduced volume of business their first attention had to be addressed to conserving their cash resources. They are to-day, I believe, looking to a planned turnover of locomotive inventory as a mechanism for controlling operating expenses and for increasing net operating income.

I cannot believe that we have reached a point where we should slacken in our efforts to improve the machine we now have. In times like these, lack of actual construction might seem to indicate a cessation of activities along sound and advanced engineering lines. On the contrary, we have had the time, which we do not always have under normal conditions, for constructive thought and research. We shall, in the course of time, see definite progress as a result of this intensified consideration.

I would not, however, merely refer you to promises of future operating values in steam locomotives, for we know that economies in operation due to the use of the modern power at this moment available represent, in some cases, savings of 20 to 40 per cent. annually on the investment.

We are confronted by a time and a situation where sentimental interest in an out-moded machine should not be allowed to prevent railroad modernisation in line with the modernisation of other, and sometimes competing, industries.

It appears from the latest returns that Great Britain maintains a lead over all other countries as regards the export of aircraft. In 1930–31–32 the total value of British exports exceeded that of the United States by £1,180,482. In 1930 British exports led by 68 per cent., in 1931 by 79½ per cent., and in 1932 by 60 per cent. In 1932 the exports were valued at £1,751,303. The total for the three years was £5,652,618.



880 B.H.P. OIL-ELECTRIC LOCOMOTIVE FOR MAIN LINE SERVICE

L.N.E.R. Main Line Oil-Electric Locomotive.

The main line oil-electric locomotive which is in the next few weeks going into service on the Newcastle-Berwick section of the London and North-Eastern Railway, is claimed to represent a distinctly further stage in the progress of oil-electric traction manufacture in Great Britain. Although not the most powerful yet built, it is intended for use, when required, with one or more similar units—a feature not incorporated in the larger individual engines so far constructed—and therefore is a step towards the utilisation of greater powers than the heaviest existing steam locomotives possess. Two similar units are under construction at Newcastle by Sir W. G. Armstrong Whitworth and Co., Ltd.

It is claimed that as regards flexibility and versatility, the new locomotive is unique. The patented electric transmission permits full utilisation of the power of the oil engine at speeds between 6 and 60 miles per hour. The locomotive is therefore suitable for heavy goods trains scheduled at 20 m.p.h. average speed and fast passenger trains running at a maximum of 70 m.p.h. Trains such as the 600-ton Anglo-Scottish expresses are beyond the ability of two such units, and higher-powered engines would be necessary, but apart from these the whole range of trains in Great Britain, from heavy mineral to fast passenger, are claimed to come within the scope of the units used singly or double-headed. In the case of the majority of overseas railways, where speeds in excess of 60 m.p.h. are rare, the whole range of locomotive duties is covered by units of this power.

The chief particulars of the locomotive are as follows :—

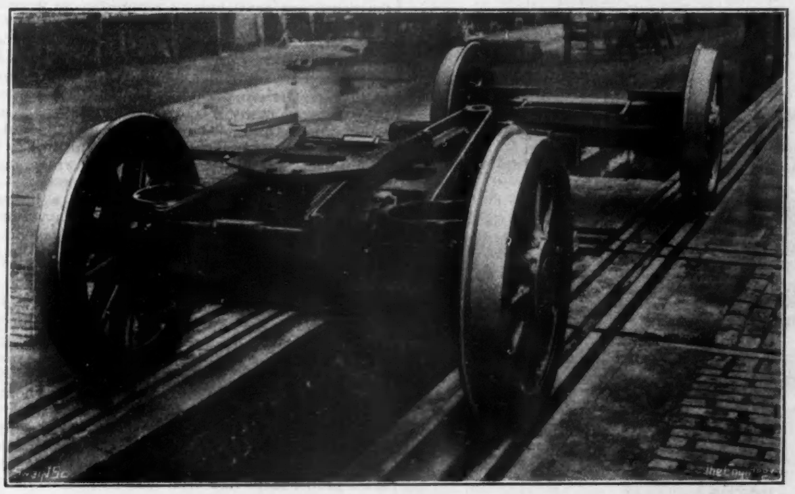
B.H.P. of main and auxiliary engines	880 B.H.P.
Weight in working order	72 tons
Maximum axle load	17 tons
Tractive effort	28,500 lb.
Maximum speed	70 m.p.h.
Loading gauge	A composite British loading gauge
Length over buffer beams	36ft. 6in.
Fuel capacity	900 miles passenger working, 500 miles goods working

Mechanical Features.—A 2–6–2 rigid wheel base type of locomotive, guided by single-axle pony trucks, was preferred to a bogie type, on account of the high speeds required. Whereas the bogie type, when two units are permanently articulated together, as in the case of the Buenos Aires Great Southern locomotives, is capable of speeds of over 80 m.p.h., the short distances between bogie centres precludes this arrangement being adopted in the case of units to be used singly. The 2–6–2 type runs equally well in either direction, arrangements having been made to avoid complete symmetry by using different designs of pony truck and truck springs at the two locomotive ends.

Compensation is carried out between one pony and its neighbouring driving axle, and between the other pony and the remaining two driving axles. The driving wheels are 48in. in diameter and the truck wheels 36in. and 12in. by 5½in. "Isothermos" axle-boxes are employed. Braking is by vacuum, with couplers for connecting to passenger stock, and is effected by a consolidated brake rotary exhauster acting through 24in. Westinghouse cylinders. Compressed air sanding is fitted.

The structure is built up on 1in. plate frames, with cross stretchers at suitable intervals, and the engine generator set is supported upon what is virtually a three-point support. The body is formed of steel sections and sheets in which welding has been adopted to a great extent. Triplex safety glass is employed for the driver's windows, and Arctic glass for the engine-room lights. A section of the roof is removable for the purpose of lifting out the main engine set during overhauls. The auxiliary engine is accommodated under a bonnet at one end of the vehicle, the bonnet being hinged and easily lifted in the same manner as the bonnet of a lorry engine. Ventilation of the interior is ensured by partitioning off the engine from the generator, and allowing the generator to draw in cool air through louvres and then to discharge it into the engine-room proper, from which it escapes through the roof ventilators.

Engine.—The engine is a British-built eight-cylinder Armstrong-Sulzer engine of the same size as that used on the Paris Ceinture Railway. Two cast iron cylinder blocks are built up on a welded steel crank chamber, which forms with the circular extension of the generator, what is virtually a single tubular unit comprising engine and generator, which can be lifted out of the locomotive, and which, when resting on an elastic seating, provides the three-point support previously mentioned. Separate cylinder heads, each with valves in removable cages, and separate fuel pumps and valve gear are provided for each cylinder. Full power is developed at 700 r.p.m. and two reduced speeds are provided for medium power and for idling, though with the arrangements made for continuous easy starting of the main engine, the latter speed is only used to a limited extent when in regular service.


THE SINGLE-AXLE PONY TRUCKS

The cylinder liners are of special cast iron, the pistons of forged aluminium alloy, and the connecting-rods are chrome nickel steel forgings. Cooling is effected by a direct driven pump circulating water through Serck radiator elements. Cooling elements are also provided for the lubricating oil. As in all Armstrong Whitworth locomotives of large power, these elements are arranged on each side of the locomotive with ducts leading up to a single fan placed in the roof. In this case a Davidson "Aeroto" fan, motor-driven and thermostatically controlled, is employed. Fuel tanks are arranged on each side of the engine-room, and are of sufficient capacity for British requirements, though larger tanks can be incorporated for overseas needs where 1000 miles between re-fuelling may be necessary.

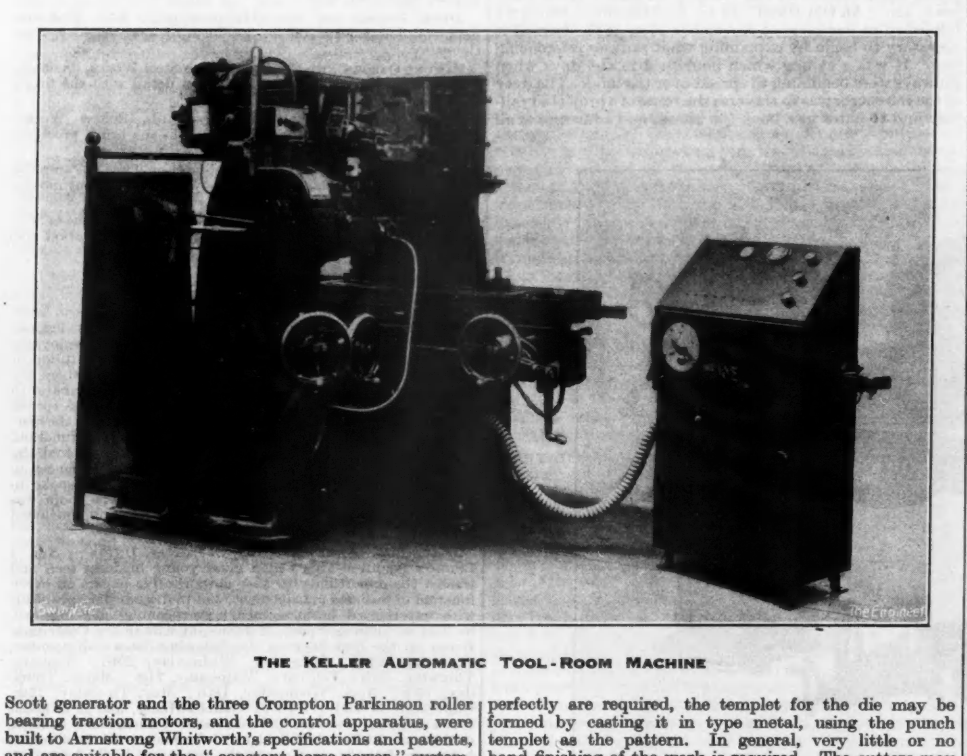
An interesting feature is the fitting of a streamline lubricating oil renovator which obviates the necessity of drawing off oil, cleansing it in renovators in the running sheds, and returning it to the locomotive. This filter is in constant use, and the make-up oil occasionally added amounts on the average only to 1 per cent. of the fuel oil used by the engine.

Electrical Transmission and Control.—The main Laurence Scott generator and the three Crompton Parkinson roller bearing traction motors, and the control apparatus, were built to Armstrong Whitworth's specifications and patents, and are suitable for the "constant horse-power" system. This control is entirely self-regulating, and the driver's duties are confined to attention to the road, and manipulation of the single controller handle and of the brake valve. It is stated that on the full power notch of the controller the output of the engine is automatically regulated within plus or minus 3½ per cent. of the nominal horse-power. When two units are coupled together, no men are carried on the second locomotive. A dead man's device is fitted, and where desirable it may take the form of the Armstrong Whitworth delayed action device, which allows the driver to leave his controller to accept tokens in single-line working.

Tests with passenger and goods trains of varying loads and speeds have been made by courtesy of the London and North-Eastern Railway Company on the Newcastle–Edinburgh line and on the Carlisle route, and are stated to have demonstrated the suitability of the locomotive for the regular service upon which it is now entering.

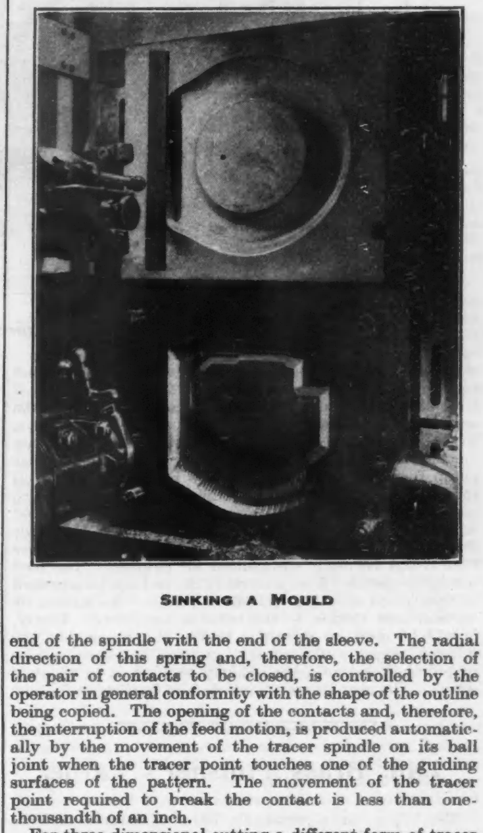
Automatic Tool-Room Machine.

AT a recent demonstration of machine tools for producing moulds for plastic materials, which was given at the Coventry works of Alfred Herbert, Ltd., the Keller automatic tool-room machine illustrated herewith formed a conspicuous exhibit. This machine is made by the Keller Mechanical Engineering Corporation of Brooklyn, N.Y.—a branch of the Pratt and Whitney Company—and operates on the milling principle, the cutter being guided in the required path by means of a tracer passing over a templet or master form. In our second engraving the machine is shown cutting the die for a lavatory seat, the master form in this case being a plaster mould. In this and similar applications a three-dimensional movement of the cutter is required. The machine can, however, equally well be set to cut with a two-dimensional movement of the tool, as, for example, in contouring a stripping die, such as that used for removing the fin from a drop forging. For three-dimensional work, the master form may be of wood, cement, plaster, or other material, or may be a finished tool, the shape and dimensions of which are to be reproduced in the form of a mould. For two-dimensional work the templet may be of light sheet brass or zinc. If a punch and die which must match perfectly are required, the templet for the die may be formed by casting it in type metal, using the punch templet as the pattern. In general, very little or no hand finishing of the work is required. The cutters may range from 0·036in. to 4in. in diameter.


THE KELLER AUTOMATIC TOOL-ROOM MACHINE

Of the three movements of the tool relatively to the work, two are provided by a longitudinal and a transverse sliding movement of the work table. The third is given by a vertical movement of the cutter head on its column. The work is secured to the vertical face of a fixture bolted to the table and supporting a similar fixture to the face of which the pattern to be copied is attached. The head sliding vertically on the column and carrying the cutter spindle also carries the tracer spindle, the point of which engages with the pattern. The upper pattern-carrying fixture is adjustable horizontally, with respect to the lower work-carrying fixture to within fine limits. A correspondingly fine adjustment is provided for the vertical distance between the cutter and the tracer spindles.

Each of the three lead screws providing the three movements above referred to is driven by an individual variable-speed motor through a gear-box containing a pair of magnetic clutches. These motors communicate their respective motions in one direction or the other, according to which of the magnetic clutches is engaged. The engagement or disengagement of the clutches is, in turn, governed by electrical contacts established by the mechanical movement of the tracer when its point experiences pressure from the pattern or templet. For contouring or two-dimensional work, the tracer consists of a sleeve within which a spindle is mounted on a ball joint near the front or work end of the sleeve. Within the bore of the sleeve at the rear end there are four electrical contacts, two of which, lying on a vertical diameter, control the up and down motion supplied by the motor associated with the vertical lead screw, while the other two, lying on a horizontal diameter, control the sideways motion supplied by the motor associated with the horizontal lead screw. Corresponding contacts are carried on the rear end of the tracer spindle. The contacts are closed by means of a spring connecting the end of the spindle with the end of the sleeve. The radial direction of this spring and, therefore, the selection of the pair of contacts to be closed, is controlled by the operator in general conformity with the shape of the outline being copied. The opening of the contacts and, therefore, the interruption of the feed motion, is produced automatically by the movement of the tracer spindle on its ball joint when the tracer point touches one of the guiding surfaces of the pattern. The movement of the tracer point required to break the contact is less than one-thousandth of an inch.

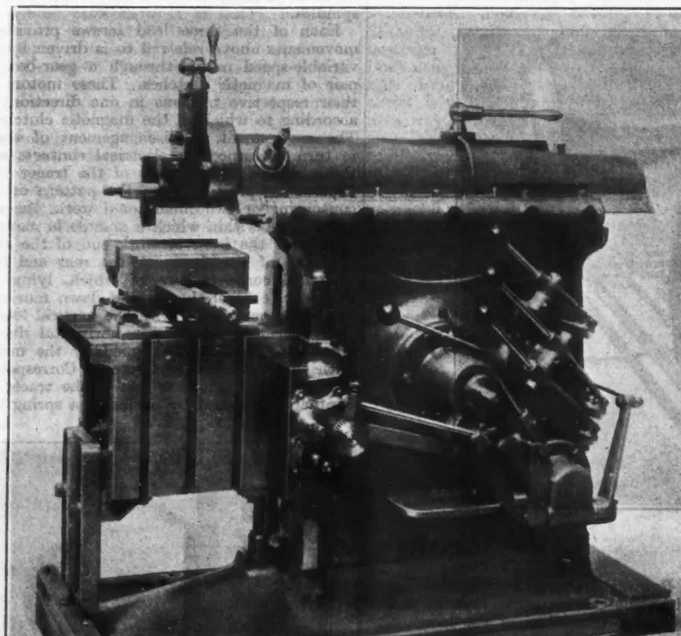

SINKING A MOULD

For three-dimensional cutting a different form of tracer is employed. This tracer follows the outline of the pattern automatically and, at the same time, continuously seeks contact with the pattern surface in the direction of the depth of the mould.

The cutter is driven by a 3 horse-power motor at speeds ranging from 80 to 3600 r.p.m. For very small milling cutters a super-high-speed spindle driven by a self-contained variable-speed motor can be fitted. With this spindle speeds of from 8000 to 11,000 r.p.m. are obtainable. All the electric controls of the machine are centralised at a separate cabinet.

The "General Purpose" Crank Shaper.

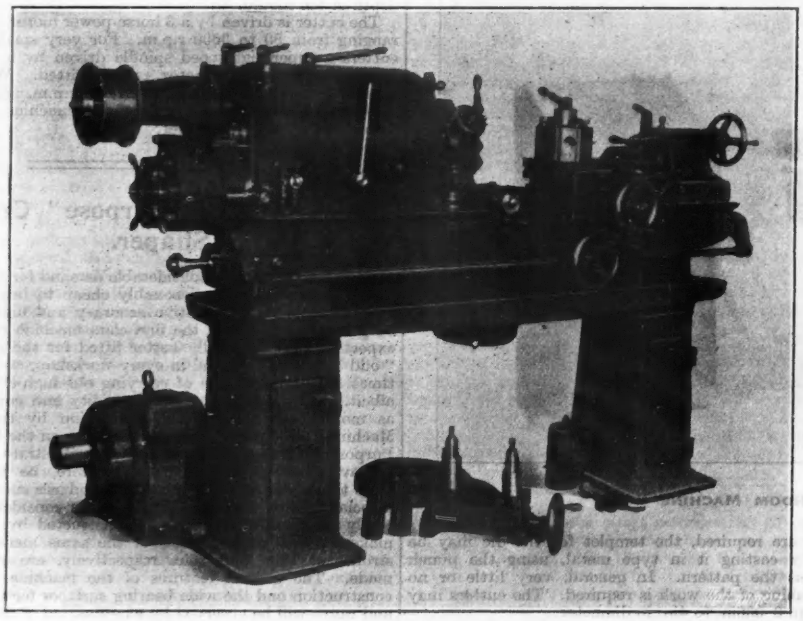
THERE is probably a considerable demand for high-class tools of various kinds reasonably cheap to buy. While in such tools the superlative accuracy and high rate of output associated with the first-class machine cannot be expected, they are really better fitted for the numerous "odd" jobs to be found in every workshop, and in busy times are quite capable of carrying out high-class work, albeit, perhaps, not with such rapidity and convenience as more costly tools. The production by the Butler Machine Tool Company, Ltd., of Halifax, of the "General Purpose" 18in. stroke crank shaper illustrated by the engraving on page 492 will, therefore, be welcomed, since this machine, while made to standards such as those associated with the name of Butler, is considerably less costly than other similar tools constructed by the same makers. Two other models of the same machine with strokes of 12in. and 26in. respectively, are also being made. The general features of the machine—its rigid construction and the wide bearing surfaces for the saddle and ram—will be observed by examination of the engraving. At the back fast and loose pulleys are mounted, the latter on ball bearings for economy when the machine is idle. In the fast pulley there is a quick-acting brake so arranged that the operator may stop the ram at any point in its stroke. Eight changes of speed from 10 to 100 cycles per minute are obtainable from gears mounted within the body and operated by ball-ended levers at the front of the machine. All the shafts within the gear-box are mounted on ball bearings. The stroke wheel is made of special cast iron, and is of single helical construction, while the crank pin and block are machined in one piece from a steel forging. The crank lever also is made of special cast iron, and it is heavily ribbed to withstand rigidly the stresses thrown upon it. It is driven by a large phosphor-bronze die. Length and position of stroke are adjustable while the machine is in motion. Nowadays, special attention is devoted to lubrication in all high-class machine tools, and this shaper is no exception. A gear pump installed in the base of the machine delivers oil through copper pipes to the link motion, ram slides, crank pin, and gearing. The oil, moreover, is filtered on both suction and delivery sides of the pump, the latter filter being so arranged on an extension of the base that it can be easily dismantled for cleaning. The feed motion is operated from a slotted disc, and can be arranged to take place at either end of the stroke. An automatic vertical feed motion to the table is also fitted. Lastly, it will be seen by reference to the engraving that the control levers, while suitably grouped together, are so placed that no confusion is likely to arise as to which is which. The gear-levers are interlocked to prevent fouling.



THE "GENERAL PURPOSE" CRANK SHAPER

7½in. Brass Finisher's Lathe.

THE 7½in. brass finisher's lathe illustrated by the accompanying engraving was made by the Selson Machine Tool Company, Ltd., of 23, Abbey House, Victoria-street, and has just been shipped abroad. It is directly driven by an electric motor mounted on an extension of the base behind the headstock, and twelve changes of speed, ranging from 25 to 500 r.p.m., are obtainable from the gear-box in the headstock. The hollow spindle has a bore of 1⅝in. The bed is 5ft. 9in. long, admitting work 2ft. 4in. long between centres. Built into the bed of the lathe there is a gear-box which gives three rates of automatic sliding feed to the saddle. Four copy screws are arranged at the tail end of the headstock, and any one of these can be readily located to agree with one of the mating nuts, which are mounted on an arm attached to a sliding shaft running the whole length of the machine behind the bed. Attached to the shaft is a chasing arm, which, on the movement of a small lever, hinges upwards or downwards. At the same time the sliding shaft is turned and the copy screw nut disengaged or engaged with the copy screw. By the use of this mechanism, much time is saved in the cutting of screws, &c. A cutting-off rest with front and rear tool holders forms part of the equipment.



7½ IN. BRASS FINISHER'S LATHE

SIXTY YEARS AGO.

How many of our readers, we wonder, could define the occupation known as "railway referencing." We do not know whether railway referencers still exist as such, but if they do they can have little opportunity nowadays of plying their calling, in this country at least. Even sixty years ago "An Old Hand" in his reminiscences, which we published in our issue of November 21st, 1873, deemed it necessary to begin by explaining what railway referencing was. It was a calling which flourished in the days when railways were beginning to spread over the land. The duty of the referencer was to traverse the route of a projected railway and to enter in a book the names and addresses of all parties interested as owners, occupiers, or lessees of the land over which the railway was to pass, and of such persons in the neighbourhood of the line on whom it would be necessary to serve notices intimating the intention of the promoters to apply to Parliament for authority to construct the railway. The book so compiled was known as "The Book of Reference to the Plans of the Proposed Railway." The referencers used to go forth in swarms towards the end of October in order that the plans and their books of reference might be completed and ready for deposition on November 30th, the day appointed by Parliament for such deposition in connection with applications for Bills to be considered in the ensuing session. Of necessity, our contributor's reminiscences were more of a personal than of a technical nature. They provide, however, an illuminating, not to say entertaining, picture of England during the railway mania of 1844 and 1845, and the years immediately preceding and following that highly speculative period. The old-time referencer was drawn from many occupations. Half-pay army and naval officers, and decayed, idle, or improvident members of the other professions flocked like vultures to the work, and in the waste and extravagance which marked the days of the mania they picked up good, if temporary, remuneration. Attired sometimes like a lifeguardsman, sometimes like a gamekeeper on holiday, they became the little magnates of the village inns, and, spending money freely to acquire the information which they sought, were objects of reverential attention from the rustic populace. Frequently they had to face opposition and to resort to guile to obtain their ends. There were owners of land who did not want the railways to encroach upon their properties, and there were post-boys who felt that the coming of the railway would deprive them of their occupations. Our contributor had some harsh and uncomplimentary things to say about the British farmer with whom naturally he was brought during the course of his work into close contact. He openly expressed his preference for rat catchers and poachers, and acknowledged that in his time they had provided him with much invaluable information, after proper steps had been taken to overcome their diffidence and shyness. Railway referencing undoubtedly had its excitements and its attractions. The period during which it flourished was one not lacking in romance and colour, for it marked the departure of an old and the beginning of a new order. It seems strange that so far as we know only one author, the late Stanley Weyman, has chosen it for the background of a historical novel.

BOOKS OF REFERENCE.

*The British Waterworks Year Book and Directory, with Statistical Tables,*1932–33. General Editor, G. P. Warner Terry. London: The British Waterworks Association, Grand Buildings, Trafalgar-square, S.W.1. Price £1 1s. to members, £1 11s. 6d. to non-members of the Association.—This edition, the fourth, is considerably larger than its predecessors, and contains full, up-to-date details of 1486 water undertakings, as compared with 871 in the 1931 issue of the book. The lay-out is the same as in the past, the first part comprising a Directory giving in alphabetical order the names of undertakings and full particulars concerning them. Section II. consists of some 156 pages of statistical tables and Section III. contains a large amount of miscellaneous information. The usefulness of this book of reference has been proved time and again, and we are sure the new issue will be found of equal, if not greater, value than its predecessors.

CATALOGUES.

PETTERS Ltd., Yeovil.—Details of the "Atomic" Diesel oil engine, stationary type.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Huddersfield.—A detailed list of the products of the Keighley Gear Company.

SAMUEL OSBORN AND Co., Ltd., Clyde Steel Works, Sheffield. —A book of some 400 pages dealing in detail with the firm's products.

FRANCOIS CEMENTATION COMPANY, Ltd., Benley Works, Doncaster.—A loose-leaf reference book of the firm's processes and activities.

A. REYROLLE AND Co., Ltd., Hebburn-on-Tyne.—Pamphlet No. 829, describing the "Castle" R-type direct-current motors and generators.

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria-street, E.C.4.—Publication No. 1374 on air filtration and conditioning plant.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Last Friday, November 10th, there was held one of the most enjoyable annual functions of the year—the dinner of the Institution of Automobile Engineers. Whether it is the fact that there are no "regular" speeches, or that there is a dance and cabaret to follow the dinner, the affair has for some reason a special character of its own, not unconnected perhaps with the personality of Mr. Basil Joy, the secretary. At this latest function, which was held at the Park-lane Hotel, Earl Howe told the assembly of members and guests some of his experiences in road racing and elsewhere, and the President also spoke in lighter vein. There were no other speeches. The room was subsequently cleared for dancing, and the function concluded eventually in the early hours of Saturday morning.

INDUSTRIAL ADMINISTRATION STUDENTS UNION: No. 1 LONDON GROUP.—This Union gives young business men and women the opportunity to hear authoritative papers on every function of business management, and to discuss their problems with experienced business men. Forthcoming meetings will be held at Thames House, Millbank, at 6.30 in the Conference Room on the first floor on the following dates:—November, Thursday, 23rd; December, Wednesday, 20th; January, Thursday, 18th; February, Wednesday, 21st; March, Thursday, 15th; April, Wednesday, 18th; May, Thursday, 17th. Omnibuses 77 and 177 go to Thames House, and it is about seven minutes' walk from Westminster Underground Station, or the trams at Vauxhall Bridge. Refreshments can be obtained before or after the meetings at the restaurant in the basement. Particulars of membership may be obtained from the Hon. Secretary, B. W. Galvin Wright, Imperial Chemical House, Millbank, S.W.1.

Railway and Road Matters.

The L.N.E.R. reports that a contract has been placed with the Westinghouse Brake and Saxby Signal Company, Ltd., for the installation of colour light signalling between Seven Sisters and Enfield Town.

The unilateral system for waiting vehicles is about to be officially tried in Jermyn-street. This is an arrangement whereby vehicles may on certain days stand on only one side of the street. They may stand on the south side on Mondays, Wednesdays, and Fridays, and on the north side on the other three days. Derby is one of the boroughs where this arrangement has been in successful operation for some time.

The number of passenger-carrying vehicles that are lighted by gas is gradually being reduced. The Railway Returns for the year 1932 show that the percentage lighted by gas out of the total number of carriages was reduced from 37½ at the end of 1931 to 34½ at the close of 1932. The percentage of those lighted electrically correspondingly rose from 62 to 65. All the 1377 passenger-carrying vehicles built or purchased during 1932 were electrically lighted.

We are prompted to follow up the paragraph herein on November 3rd as to the bell on the signal-box at Hebden Bridge by the remark that the use of a bell for the purposes named is quite irregular. There was a time when that was part of the equipment of a signal-box, but for a good fifty years that has not been the practice of any leading British railway. The companies did not consider it their business to warn passengers of the approach of trains, and, further, the abolition of the bell secured greater punctuality.

Herein on January 20th last we recorded that Mr. John Miller, the engineer of the North-Eastern Area, London and North-Eastern Railway, had found short fishplates, with two holes, so satisfactory that they had been adopted as the standard on that area instead of the 18in. four-hole plate. The Great Western is now experimenting in the same direction, and Mr. A. S. Quatermaine, that company's assistant chief engineer, at the G.W. Debating Society on October 19th, spoke of the successful experimental adoption of a 10in. two-bolt fishplate, instead of one of 18in. with four bolts; if, after further tests, the joint was found satisfactory for standard use, an economy of £5000 per annum would accrue from the change.

The Institution of Railway Signal Engineers, on the evening of Wednesday, November 8th, discussed the question of the possibilities of danger side failures of track circuits, caused by sand, dirt, grease, &c., on the rails. These features are liable to impair the contact between wheel and rail and to cause a vehicle that may occupy a section or be standing foul not to short circuit the track battery and thus allow the protecting signal to remain at "clear"—which is a failure on the danger side. This matter was mentioned by Lieut.-Colonel Mount in his annual report on the accidents of 1931, when he said that there had been two such accidents—neither of them serious—through such failures. He added that the matter was receiving the attention of the railway companies. The discussions on November 8th indicated that the fault did not lie with the signalling department, and that the chief mechanical engineers were seeking means whereby the locomotive, after having deposited sand on the rail, blew it or washed it off after the driving wheels had passed.

Following what we said on October 27th as to the fewer companies, as represented by their locomotives, using Carlisle and York, we might also refer to Peterborough. There are two stations in the city—what was the Great Northern is now the North Station, whilst the former Great Eastern is Peterborough South. Until the grouping of the companies, five railways ran into Peterborough—the Great Northern, Great Eastern, Midland, London and North-Western, and Midland and Great Northern Joint. The last-named is still there and under the same name, and, in addition, the London and North-Eastern and London, Midland and Scottish. Although the Great Northern was always the principal company, it did not arrive there until the line was opened from Boston on October 17th, 1848. The Midland entered Peterborough from Stamford on October 2nd, 1846, and then joined the London and North-Western line from Northampton, which was opened on June 2nd, 1845. The last-named did not, however, enter the present North Station. A little-known fact is that in running between the Great Northern and Great Eastern stations a length of the Midland had to be traversed, and thus to-day the London and North-Eastern, in order to get from the eastern to the northern section, has to pass over 34 chains of London, Midland and Scottish metals.

One of the benefits secured by the Light Railways Act, 1896, is that gates need not necessarily be provided at the level crossings of the railway over public roads. Safety is secured by speed limits and whistle boards on the railway and conspicuous warning boards on the highway. That is done at some of the crossings on the Totton, Hythe, and Fawley Light Railway on the Southern, and one such was at Frost-lane, where there was a collision, without fatal results, between a train and a motor car on November 15th, 1926. That mishap was investigated by Colonel Mount, whose report was reviewed by us on April 15th, 1927. Another crossing without gates is at Jacob's Gutter-lane, where a more serious accident occurred on July 26th. On that occasion the driver of a motor lorry was killed, and the coroner's jury who inquired into the facts considered that the train had been handled negligently, and that there should be gates. Colonel Anderson, who investigated the case on behalf of the Ministry of Transport, however, found that there was no negligence by the trainmen, and was of opinion that the evidence indicated conclusively that the accident was entirely due to the rash driving of the motor lorry. That officer also said that the accident occurred on the side of the level crossing where the view of lorry and train was best, and, in itself, constituted no justification for requiring the erection of gates. Conditions on the other side of the crossing had, though, changed, and the road-user's view of the railway had deteriorated. Colonel Anderson recommended that the local authorities and the Southern Railway should consider the provision of light signals to give a warning on the roadway when a train was approaching.

Notes and Memoranda.

A society for the preservation of old Sheffield tools and machinery has been formed. The Hon. Secretary is Mr. W. H. Bolton, of the Applied Science Department, Sheffield University.

The latest report issued by the National Federation of Iron and Steel Manufacturers shows that the output of pig iron in October was 373,300 tons, against 359,700 tons in September and 275,600 tons in October, 1932. The output of steel ingots and castings was 668,300 tons, which was practically the same as in September, but represented an increase of 228,500 tons compared with October, 1932.

An excerpt from the *Edgar Allen News* :—"The large and ever-increasing use of alloy in case-hardening steels in high-grade gear work has made the heat treatment department of any gear factory one of its most important sections, if not the most important. Accurate and costly machining operations are entirely wasted if the material does not possess adequate physical properties for the duties, and these in many cases nowadays can only be obtained by most careful attention to heat treatment."

A new type of flame, known as the diffusion flame, has been devised for forging operations. According to Mr. Henry O. Loebell, vice-president of the Combustion Utilities Company, New York, this new burning method provides alternate layers of gas and air slowly flowing through a furnace so that combustion takes place only at the zones where air and gas meet. When in operation, an unburned gas blanket flows over the heated steel, preventing it from forming scale, and the flame is said to enable work to be heated to the forging temperature at unheard-of speeds.

It appears from experiments carried out for the Safety in Mines Research Board by Messrs. T. N. Mason and R. V. Wheeler, on dusting in coal mines for the reduction of explosions, that as compared with the shale dusts commonly used, limestone and gypsum have been found markedly more effective in rendering coal dust incapable of propagating flame. A warning is given, however, that when assessing the value of an incombustible dust for treating coal dust on mine roadways, the ease with which it can be dispersed as a cloud, more particularly after it has been exposed for some time to the atmosphere of the mine, must be considered. In this respect gypsum is more liable to cake than either limestone or shale dust.

Some experiments carried out by Mr. R. L. Dowdell, and communicated to the American Society for Steel Treating, on the ageing of miscellaneous steels when treated for permanent magnets, show that tempering at 100 deg. Cent. for 12 hours, followed by tempering in the magnetised state until about 5 per cent. of magnetic induction is lost, followed by sacrificing 5 per cent. more by a reversed demagnetising field, gave the greatest stability of any of the treatments used. This treatment indicates that both hardening and magnetic strains should be partially removed in order to stabilise permanent magnets regardless of their composition. The several tables included give the treatment and ageing characteristics over a period of about ten years.

A pamphlet has been issued by the British Aluminium Company, Ltd., on the M.B.V. process for the surface treatment of aluminium and its alloys, by Dr. G. Eckert, which was one of the prize-winning essays in the 1932 International Aluminium Competition. The bath used in the M.B.V. process is composed of an aqueous solution of anhydrous sodium carbonate and anhydrous sodium chromate at a temperature of 90–100 deg. Cent. The colour of the M.B.V. film varies from light to dark grey, and while mechanical resistance of the film is not exceptionally high, it will resist the action of ordinary bristle brushes. A secondary treatment, which consists in maintaining the part concerned for 15 min. in a 3–5 per cent. solution of sodium silicate at 90 deg. Cent., followed by rinsing in water, increases the hardness of the coating appreciably and also improves its resistance to corrosive action. The M.B.V. film is very adherent and cannot be detached by folding, rolling or by pressure as it possesses a high elasticity.

It appears from a note by Major C. C. Turner, in the *Daily Telegraph*, that while some of our Continental rivals may be embarking on some spectacular aerial voyages, our own efforts in this direction are noteworthy, although they may not receive so much public attention. Thus since March, 1926, the R.A.F. has carried out thirty extensive formation cruises of three or more aircraft, the route aggregate being 250,000 miles. Many of the R.A.F. formation flights are periodical and by way of routine. Thus there have been six from Cairo to the Cape and back, with Army co-operation exercises *en route*, and others from Cairo to Somaliland, East Africa, and Rhodesia. Before the present cruise there have been four to West Africa. A remarkable circumstance of these British cruises has been their comparative freedom from serious mishap. One fatal accident has occurred during these operations, resulting in two deaths. The R.A.F. flies some 25,000,000 machine miles in a year, and it "polices" more than 1,000,000 square miles of the world.

The Annual Report of the Building Research Board, Department of Scientific and Industrial Research, shows that by far the largest number of failures which are reported to the Station are concerned with plasters and renderings. Hundreds of specimens of plaster have been submitted for examination, and in the majority of cases it could not be said that the materials were defective. "It is probably safe to assume," says the Report, "that haste is the most important of the changed conditions which give rise to these failures in lime plaster work; undercoats are not allowed sufficient time to carbonate and dry thoroughly before applying finishing coats; manipulation is a more perfunctory matter than it was traditionally; fresh plaster is more liable to disturbance; poorly seasoned timber may warp and shrink; electricians, gas-fitters, and pipe fitters may be expected to work above them at a time when plaster ceilings are very sensitive to vibrations. As a result of these tendencies, it is considered that the very low strength of a lime plaster ceiling on lathing should be augmented by an addition of a suitable material having definite hydraulic setting properties."

Miscellanea.

The old Reliance Gold Mine at Penhalonga, Rhodesia, is to be re-opened.

Some large deposits of molybdenum ores are said to have been found in the Rokko hills, near Takarazuka, Japan.

The Blue Star Line has decided to order two 12,000-ton ships equipped with refrigeration apparatus for trade on the New Zealand route.

Two more blast-furnaces have been blown in by Dorman Long and Co., Middlesbrough, one at Cleveland and the other at the Acklam works.

Paddington's new giant timetable clock, fully described in The Engineer of September 29th, 1933, which is claimed to be the biggest moving figure clock in the world, started work on Wednesday, November 8th.

What is claimed to be the largest land aeroplane in the world, the "K 7," has been completed at the Kharkov factory under the direction of the engineer Kalinin. According to the *Manchester Guardian*, it is an all-steel model, made entirely of Russian material.

Materials of construction, to use these terms in their fullest significance, will be demonstrated and explained in the language of their latest developments at the Fourteenth Exposition of Chemical Industries, which is to be held at Grand Central Palace, New York, December 4th to 9th, 1933.

The electric generators for the Boulder Dam powerhouse in America will be of 82,500 kVA each at unity power factor, three-phase, and are designed for 50-cycle generation at 150 r.p.m., and 13,800 volts or 60-cycle generation at 180 r.p.m. and 16,500 volts. The turbines will work under a head of from 450ft. to 560ft.

There is a brief account in the *South African Mining and Engineering Journal* of the efforts of a young Rhodesian. Michael MacDonald is only seventeen years old, but he works a gold mine alone, with the help of a dozen natives, and is getting ore assaying 9 dwt. per ton. He is putting in a battery of drop stamps to work the ore.

It is reported that the Sorima Company, which has been responsible for the salvage of the gold in the wreck of the "Egypt," off the coast of France, proposes to carry out experiments in diving to depths greater than those reached in the case of the "Egypt." These experiments will be conducted in combination with trials of artificial lighting in the Mediterranean.

Some indication of the state of trade in the Birmingham district may be gathered from the fact that the Austin Motor Company, which is now turning out from 1600 to 1800 cars a week, is extending its premises. A new factory for making motor tire valves has also been established in the district by an American firm, while a number of other existing factories are being extended.

Prior to the war and over a period of five years only ten trucks and 450 light cars were assembled in Russia. During the five years 1928–32 the U.S.S.R. has built up an automobile industry which has already turned out nearly 58,000 cars.. On August 16th, the Stalin Auto Works in Moscow had turned out 30,000 cars. One car in every ten minutes is now being produced at these works.

A new gasholder, according to the *Iron and Coal Trades Review*, is being erected at the Neunkirchen Ironworks in place of the waterless gasholder which was destroyed by the explosion in February last. The new holder is to be of the standard water type, and will have a capacity of 30,000 cubic metres; a new position has been chosen near the Bauernhaus steel works. A smaller gasholder of 3000 cubic metres is to be erected for the coking plant.

The Chinese Government is said to have finally confirmed the contract to the German Gutehoffnungshütte for the construction of an iron and steel plant near Pukow, China. Instead of 500,000 tons, as originally planned, the plant will produce only 250,000 tons annually—as the coal near Pukow is unsuitable for iron production and must be supplied by the far-distant Kao Kang mines of the An Yua district in Kiangsi. The total cost of the plant will be £4,000,000, and it is expected to start production in 1937.

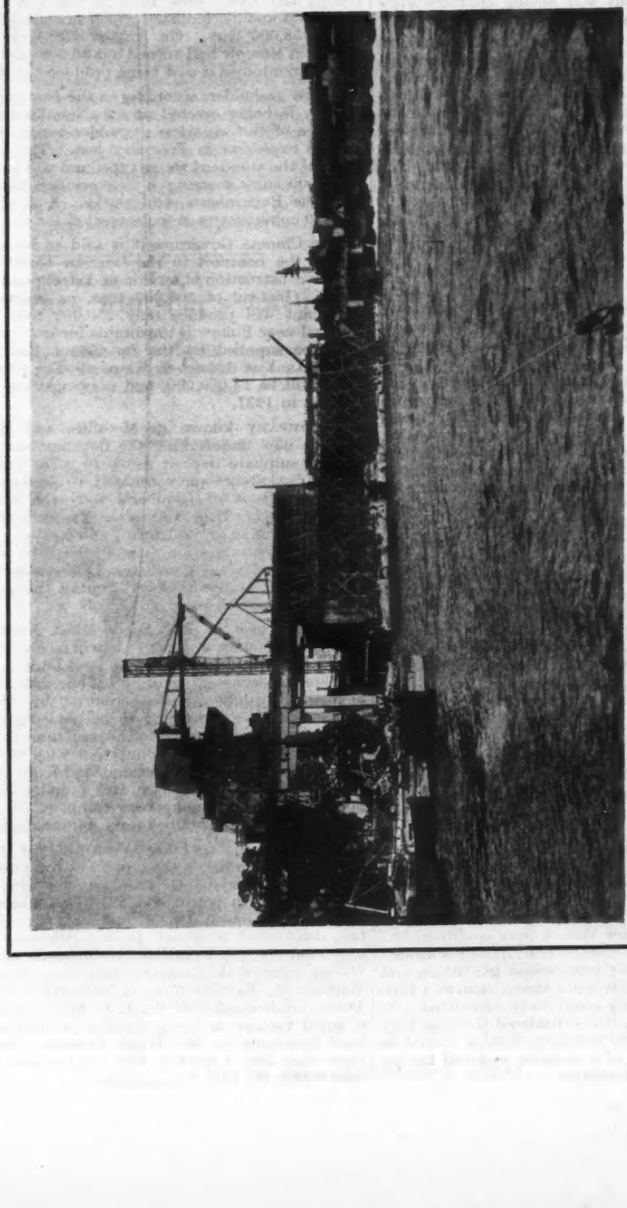
A company known as Metallics and Non-Metallics, Ltd., is now undertaking the development of a natural sodium sulphate deposit some 40 miles north of Maple Creek, Saskatchewan, estimated to contain more than 25,000,000 tons of Glauber's salt—the largest deposit of its kind in the British Empire. The sulphate as it occurs in the lake is in crystal form, and contains 59 per cent. water of crystallisation, which must be driven off in connection with the conversion of the sulphate into salt cake. Plant construction will entail the expenditure of 150,000 dollars.

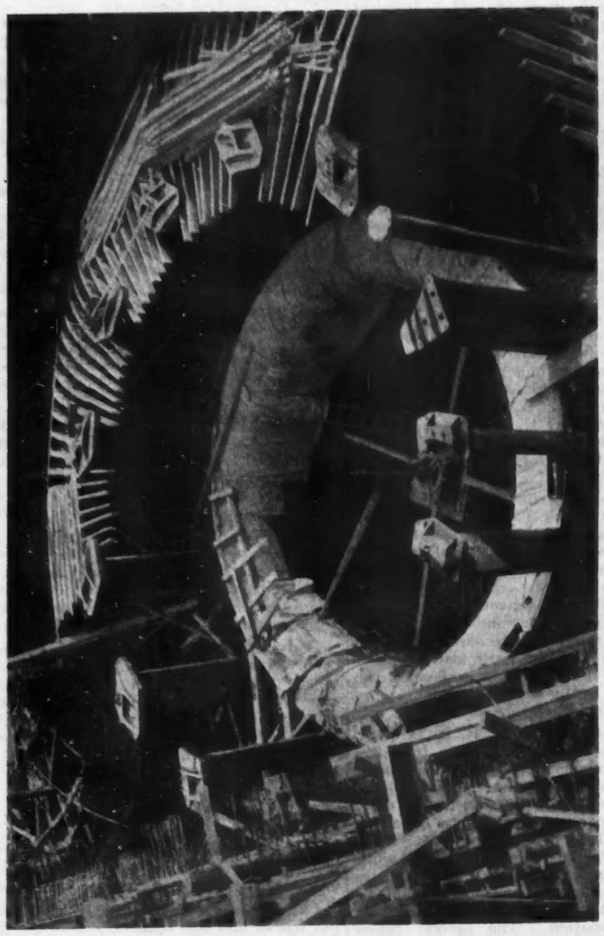
In an article in *The Edgar Allen News* on dredger tumblers, the author says: "It will be obvious from what has here been written, that the steel founder can perform a valuable service in devoting his energies to the solution of practical difficulties experienced by his customers. There is always something to be gained and nothing to be lost by communicating to the steel founder the practical troubles experienced in connection with the use of steel castings in particular operations, and more often than not collaboration between user and founder can result, as in the instance of manganese tumblers, in an improved product that successfully meets requirements."

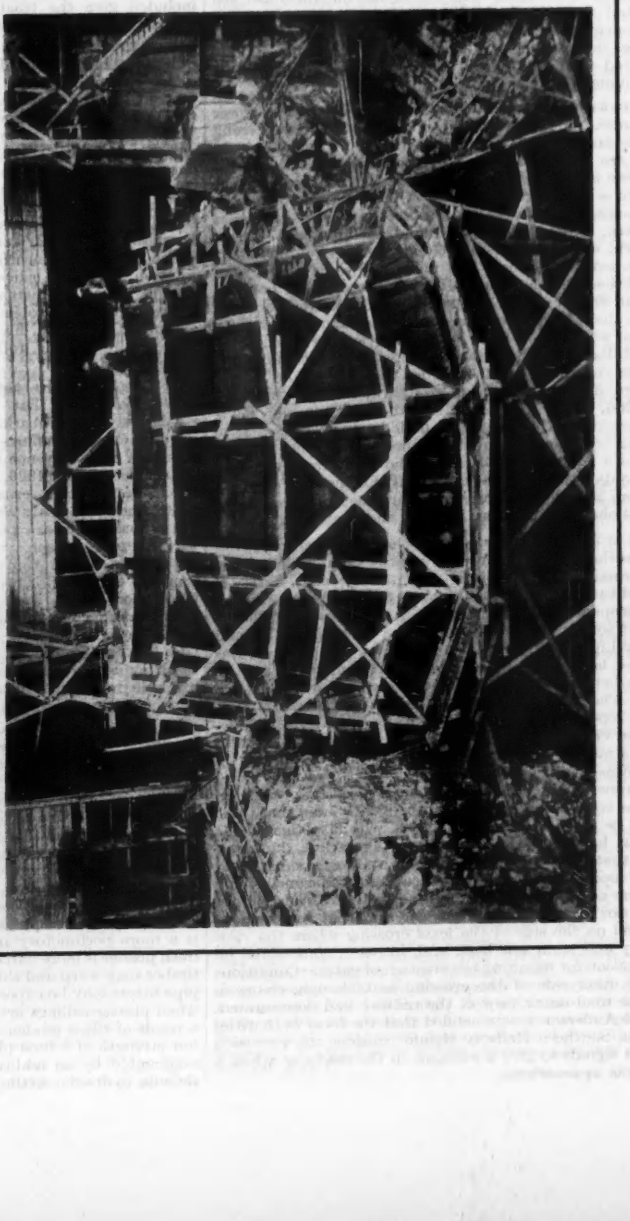
It is claimed, says the *Morning Post*, that there is enough oil shale below the ground at the village of Sutton Poyntz, near Weymouth, to supply the whole of England indefinitely with petrol and oil. This claim is made by an Italian engineer, Dr. M. Marconi, who states that he has discovered a secret process whereby oil can be extracted cheaply from the vast deposits of shale on the Dorset coast. A company has been formed by Dr. Marconi, Mr. Herbert Weld, of Lulworth Castle, influential Dorset landowners, and Mr. T. B. Bertuccioli. At present a small factory is being erected at Sutton Poyntz on land belonging to Mr. Hugh Diment. The promoters state that they expect to find employment for 100 local men within the next five months.

VARGON HYDRO-ELECTRIC POWER STATION

(For description see page 482.)







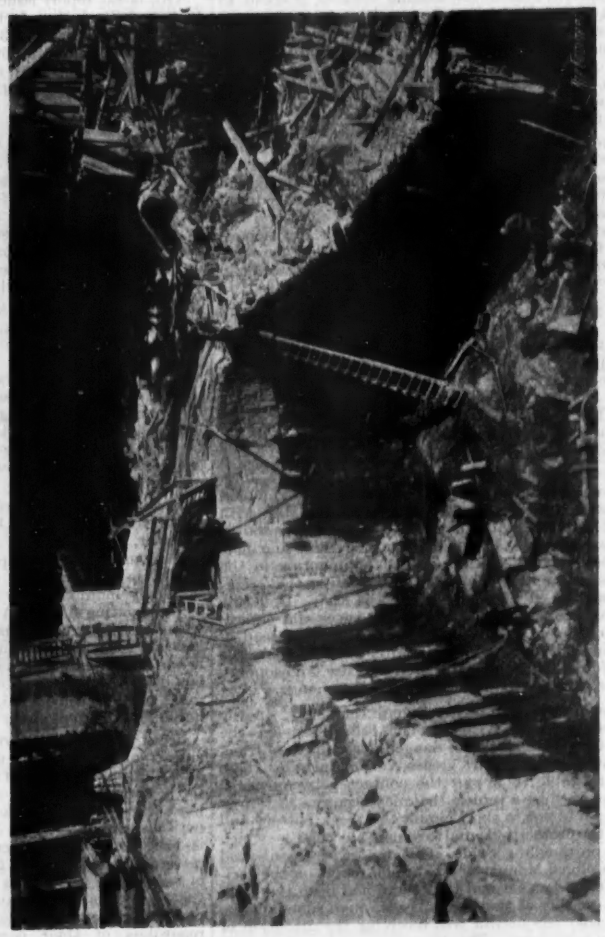


FIG. 19 (ABOVE)—VIEW OF POWER STATION FROM DOWNSTREAM—MAY, 1933
FIG. 20 (BELOW)—STEEL LINER FOR DRAUGHT TUBE OF No. 1 TURBINE

FIG. 21 (ABOVE)—LOWER GUIDE WHEEL RING AND SUPPORTING COLUMNS OF No. 1 TURBINE—APRIL, 1933
FIG. 22 (BELOW)—ROCK EXCAVATION FOR DRAUGHT TUBE OF No. 1 TURBINE

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NOVEMBER 17, 1933.
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DEATH.

On November 14th, at West Kirby, Cheshire, Bertram Henry Majendie Hewett, M. Inst. C.E., M. Am. Soc. C.E., Chief Engineer of the Mersey Tunnel, aged 59 years.

NOTICES TO READERS.

⁂ *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TWO STANDARDS.

The evidence that this country is gradually rising from its industrial depression increases daily in strength and volume. The fear that rising hopes may be doomed once more to disappointment is slowly being replaced by a feeling of confidence. Inquiries are more frequent and firmer, and order books are beginning to fill up; employment is increasing rapidly and the prospect for the immediate future is good. All that now may be dreaded is some political action, either at home or abroad, which will check the acceleration. Provided that we are spared that infliction the revival rests with the producers and distributors themselves. The home markets are fairly secure, but we cannot live on our inland trade. Our manufacturers and our salesmen must look overseas, for it is there that we must seek for business to restore our trade to its normal dimensions, and it is just there that we have the greatest anxieties to face. There is no question of the severity of the competition. It is so severe that some people have spoken of it as unfair. Japan's competition has been so described, though it is difficult to see any unfairness in that kingdom producing cheaply if its economic system allows it. We cannot produce as cheaply as she can, because we have decided to insist upon a higher standard of living; it is absurd to charge her with unfairness because she retains a standard of living which suits her, but which we think too low. Indeed, complaints and recriminations are fruitless; what we have to do is to make our markets in the face of the competition of other countries, and the only unfairness of which we have any right to complain is that imposed by our own legislation or regulation, or customs of trade, or taxation, or rating, or cost of transport, and so on. Such things may be fetters about our ankles and may impose conditions which make revival difficult or doubtful. But it is our own business to set them right.

Amongst such factors we have to place for consideration, not for hurried condemnation, the standards set up by the B.S.I., and other standardising bodies. There is little doubt that in certain markets the price which accompanies the British standard of quality is too high. The foreigner with lower standards and lower prices secures the orders. We have already referred at some length to this important question—on June 3rd, 1932, and on September 29th last, when we printed a long letter which the British Standards Institution had sent to the British Chamber of Commerce in Buenos Aires in reply to a complaint made by the Chamber of the high price and unnecessary excellence of British goods. We return to the subject again, because of its great importance, and because further light has recently been thrown on one of its aspects. It will be recalled by those who followed the Buenos Aires correspondence that the possibility of adopting two standards was adumbrated. Let it be admitted that many purchasers are wise enough to pay the extra price for goods of quality, and even that more could be induced to do so by better salesmanship. There still remain many who are quite content with the lower standard offered by foreign producers; who do not ask for the safety of British machinery, and regard its long life as a hindrance to progress. They are quite prepared to subject life and limb to reasonable risk and do not mind overstressing machinery and structures so that they wear out rapidly. There is no question that this kind of market exists, and none, that we cannot touch it—because our prices are too high. We are faced then with two alternatives to the loss of the trade; either the production of a lower standard to suit these markets, or the retention of the present standards, but at a price equal to or below that of our competitors. The latter is almost unthinkable for such goods as we have in mind. In these days there are no national secrets about methods of manufacture; what one nation can do another may. The price for the same thing cannot be appreciably reduced below that of other nations by a new method of production. It can only be lowered by offering something different or by reducing the standard of living. It is true that the prices of many engineering products are maintained by price rings and associations, but it is very doubtful that they are excessive for the quality given. Hence, one of our two alternatives is removed, and we are left with the possibility, or, let us say, the desirability, of setting up two standards, one of quality A, and the other of quality B. The arguments for and against doing that have not yet been fully explored, but there is, undoubtedly, a feeling that it would be a retrograde step, and that sooner or later the lower standard would drive the higher from the field. The obvious answer to that contention is that if the lower standard satisfied the market, there is no reason why the higher should be retained. Another argument against two standards is that confusion would certainly occur, and that the British reputation would suffer just as certainly if the lower standard failed. Others contend that even a lower standard would not capture the market against local producers and cheaper competitors, and there appears to be a general consensus of opinion that more harm than good would be done by anything which prejudiced the reputation for excellence which this country enjoys.

In a sense, it may be said that our British Standards are defeating themselves. Before they existed all manners and qualities of products were made, and the British manufacturer could compete hopefully in any market in the world because he modified the quality to suit the price obtainable. But since the coming of British standardisation, the advantages of following standard specifications on the home and Empire markets are so great that alternative designs and qualities are, to a large extent, disappearing. Furthermore, the foreign purchaser insists on using the British specifications when he orders goods in Great Britain, but will accept the specifications of other countries if he is ordering in them. Until we get international standardisation that will be a constant difficulty. Of course, there are always plenty of manufacturers in this or any country who are prepared to supply goods not made to the national standards, and it might be thought that these people would supply the lower class of goods required by cheap markets. Fortunately, or unfortunately, that is only partly true. The general and increasing tendency, as we have said, is to specify British standards, and that immediately settles the quality, and, to a very large extent, the price. The position is, then, that we are not prepared to give up our high standard, that two standards will not be considered, and that our prices cannot be appreciably reduced. Success, in these circumstances, must depend upon the ability of the salesman to convince the purchaser that the extra cost is worth while. We are proud to be able to record the evidence of overseas observers that it is the first order which counts; after that, the excellence of the British products favours the salesman.

Street Design.

Nearly everyone with experience of modern traffic conditions in large towns must, we imagine, have amused himself in times of leisure by attempting to plan some ideal lay-out of streets in urban areas by which all troubles of traffic congestion would be overcome and all the demands of road users met in full. The subject, indeed, is so fascinating that nearly every writer upon it has allowed his imagination to run riot, so that, in effect, anything of value he may have had to suggest was concealed beneath a load of quite impracticable visions. Doubtless, the provision of "throughways," raised upon viaducts over our present streets, and limited for use to the higher speed vehicles, together with access ramps and all the other typical, but impossibly expensive, paraphernalia of the usually suggested scheme, would cure urban areas of acute congestion. But, short of taking the whole War Debt due from this country to America and diverting it to a directly utilitarian purpose, the likelihood of any such scheme ever being carried out on the large scale it demands is remote. An entirely sane paper which takes street lay-out as it is to-day and modifies it in accordance with modern demands is, therefore, a welcome addition to the literature on the subject. Last Monday, Mr. H. Allen Tripp read such a paper before the Institute of Transport. He is an Assistant-Commissioner of the Metropolitan Police, and is, therefore, in a position to view the question of transport, not, perhaps, from an independent, but certainly from an unbiassed standpoint. Certainly, in his review of the subject and the suggestions that he makes, he keeps a tight rein upon his imagination, so that the improvements he advocates involve no heavier expenditure of public funds than could easily be borne. The suggestions, in fact, are so sane, and arise so surely from an analysis of the requirements of both the road itself and its users, that one labels the paper "common-sense" at once.

Mr. Tripp adopts an attitude half-way between that which calls for a road that meets the needs of the traffic upon it and that which considers that the traffic should be regulated to suit the roads. His discussion, for instance, of the rights of various road users comes under the latter head. In his own words—"At present, inheriting the habits of a leisurely past, the wealthy shopper generally expects his or her vehicle to wait outside the shop while purchases are made. This, in the crowded thoroughfares of inner London, has ceased or is ceasing to be practicable, and in view of traffic necessities the demand cannot be conceded as a just requirement. Nearby standing accommodation (off the road) . . . will have to be the solution . . ." Or, again, "The demands made by tramcars are heavy. They demand a track upon which they shall have priority over other traffic, and also expect that when they stop for passengers . . . all other traffic going the same way shall stop also . . . the demands are far too high to be conceded to one specialised form of transport." Similarly, he believes that the claims of frontagers cannot be met in full. "The demand that highway accommodation should be provided in order to further private gain, at the expense not only of the public purse, but also of the convenience and even safety of public traffic, is thus another demand that cannot equitably be conceded." Premises which attract local traffic, in fact, must provide at their own expense standing space off the highway for the vehicles. Such points, and many others, which Mr. Tripp brings forward are concerned with the fitting of the traffic to suit the roads. On the other side—making the roads to fit the traffic—he has so much to say that it would be difficult to do justice to it by means of extracts. Arising from a careful analysis of the requirements in a good road and the equitable claims of road users, he divides streets into two classes—the arterial and the distributive. The latter exhibits little alteration from those we know to-day. But in the former everything is subordinated to the main object of keeping the traffic flowing freely. The highway ends of side roads are closed and built upon. At crossings, of which there are not more than three to a mile, there are roundabouts or traffic signals. The road is wide and divided centrally by an island, which is interrupted at long intervals to suit cross roads and accommodate taxi-ranks. Standing of cars on the road surface is prohibited. Pedestrians are only permitted to cross at certain clearly defined points, and under the protection of light signals. That there shall be no possibility of their attempting to do so elsewhere, the pavement is railed off from the road, and the railing is only interrupted at omnibus stops, near the heads of taxi ranks, and at pedestrian crossing places. Great arterial roads radiating from the city would be designed on a similar plan. "We would have our road fenced on both sides from end to end. No houses whatever fronting it should be built. Roundabouts of adequate dimensions having been provided at each of the intersections, these would be the only entries permitted. At each junction a footbridge, approached by easy ramps, would be provided. No pedestrians would under any circumstances be allowed to set foot on the carriageway save in case of emergency . . . It may be objected that an arterial road of this character with so few approaches would be in the nature of a fence as between the adjoining portions of the country. The answer is that it would be less of a dividing line than any new railway track."

The greatest resistance to any such scheme as that advocated by Mr. Tripp is likely to be exerted by the pedestrian. The motorist, we think, might be not unwilling to waive any right he has to leave his car before the premises he wishes to visit in consideration of the increased speed and safety of travel upon the new arterial road. But the pedestrian—and the motorist is almost as much a pedestrian as anyone else—still clings in this country to his ancient right to use the roadway at any place and time to suit his own convenience. To quote Lord Buckmaster, "pedestrians are on the road by right, and the whole of the motor traffic is there by licence, and people there by licence have no right to interfere with the rights of people who were there before motor cars were thought of." In other countries, however, the pedestrian has already had to submit to a limitation of his rights, and in certain cities of the United States he is even subjected to a fine if he attempts to cross the road elsewhere than at certain clearly defined points. In the words of Mr. Tripp: "It is just as if there were a right of way from time immemorial over land upon which the sea has now suddenly encroached. People may still assert their right to the footway, but if great waves are apt to be washing right across it is not always policy to exercise the right." If we may add one more argument to the many that Mr. Tripp brings forward, the restraint exercised upon the pedestrian by the railing of the road, and the restraint exerted on the motorist by the central island, might between them do much to bring about a much-desired reduction in the appalling death-roll of the road.

BOOKS RECEIVED.

Steel Makers. By Harry Brearley. London: Longmans Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 5s. net.

Power Sales. By Dean Taylor. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 10s. net.

Riemen-und Seiltriebe. By Dr.-Ing. E oom Ende. Berlin: W. de Gruyter and Co., Genthiner-strasse 38, W.10. Price 1·62 marks.

Air Conditioning. By J. A. Moyer and R. U. Fittz. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 24s. net.

Wireless Receivers: The Principles of their Design. By C. W. Oatley. London: Methuen and Co., Ltd., 36, Essex-street, W.C.2. Price 2s. 6d. net.

An Introduction to Aerodynamics. By R. Poole. London: The Draughtsman Publishing Company, Ltd., 96, St. George's-square, S.W.1. Price 2s. net.

Education for Industry and Commerce in England. By A. Abbott, C.B.E. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 5s. net.

Internal Combustion Engines: Theory and Design. By V. L. Maleev. London: The McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 24s. net.

Influence of Temperature upon the Strength Development of Concrete. By N. Davey, B.Sc. London: His Majesty's Stationery Office, Adastral House, W.C.2. Price 2s. net.

The Crystalline State. Edited by Sir W. H. Bragg, O.M., K.B.E., &c., and W. L. Bragg, D.Sc., F.R.S. London: G. Bell and Sons, Ltd., York House, Portugal-street, W.C.2. Price 26s. net.

British Waterworks Year Book and Directory, with Statistical Tables, 1932·33. Edited by G. P. Warner Terry. London: The British Waterworks Association, Grand Buildings, Trafalgar-square, W.C.2. Price 31s. 6d. net.

The Sulzer Single-Tube Steam Generator.*

By Professor A. STODOLA, Zurich.

No. I.

THE Sulzer single-tube steam generator—illustrated and described in THE ENGINEER of October 14th, 1932, consists of a continuous tube, constructed by welding, in which the feed water is preheated and evaporated, and the resulting steam superheated. The increase in volume of the water and steam raises the velocity of flow in such a way that it is quite impossible for steam bubbles to remain on the sides of the tube, and heat transmission is considerably improved. Careful regulating tests on one of the first of these steam generators to be constructed prove that the superheat temperature is strictly under control and that the working medium passes from one state into the next without any trouble, even when the load on the boiler fluctuates greatly and suddenly.

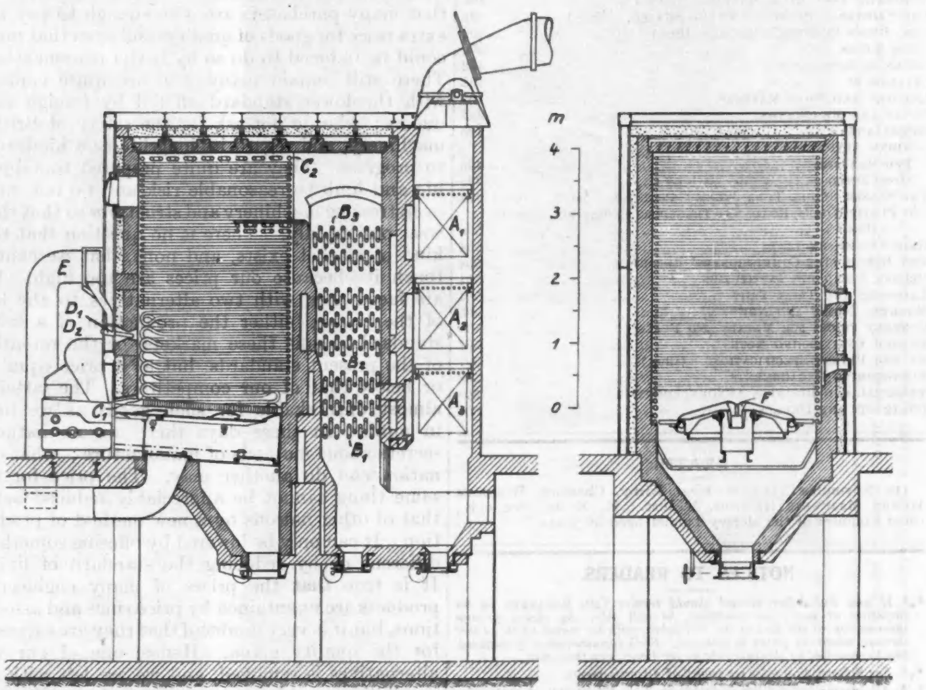

FIG. 1—SULZER SINGLE-TUBE BOILER IN A DYE WORKS

Pressure, 100 *atm.; Steam Temperature,* 400 *deg. Cent.; Output,* 7·5 *Tons of Steam per Hour.*

A_1, A_3—Preheater for low-pressure feed water.
B_1—Inlet of high-pressure feed water.
B_2, B_3—Preheating zone.
C_1—Inlet to combustion chamber.
C_2—Outlet from the boiler.
D_1, D_2—Oil burners.
E—Primary air inlet for oil burners and secondary air for coal firing.
F—Coal passage in underfeed stoker; left and right of the grate, clinker removers.

Naturally, the counterflow principle is adopted, *i.e.*, the feed water is introduced where the flue gases leave the generator, and evaporation and superheating take place where the tube is subject to radiation from the burning fuel.

THE FIRST SINGLE-TUBE GENERATOR.

The first commercial Sulzer single-tube steam generator was installed in the dyeing and bleaching works of Charles Weber, Ltd., Winterthur, and was started up in 1932. This steam generator, illustrated in Fig. 1, has a heating surface of 195 m.², of which 74 m.² are in the combustion space; the tube is 1300 m. long. Steam is raised at 100 atm. gauge pressure and 400 deg. Cent. temperature and drives a De Laval turbine of 500 kW output, and also supplies the works with heating steam, for which purpose the steam is condensed at a pressure of 9–10 atm. abs. in a high-pressure condenser (a "steam transformer") and then led back to the steam generator. The heat of condensation evaporates the "cooling water," which is at a pressure of 8 atm. abs., and is preheated in a flue of the steam generator. Fig. 2 shows the front of the steam generator.

In larger units—as, for example, in the steam generator, raising 18 tons of steam per hour, supplied for the district heating station of the Technical University of Zürich—the arrangement of the tube is as shown in Fig. 3.

The type of welding adopted by Sulzer Brothers consists, as shown in Fig. 4, in expanding the ends of the tubes and inserting in them a nipple provided with a cone at each end; the nipple ensures correct alignment and prevents drops of the weld metal penetrating into the interior of the tube. The slight reduction in bore caused by the nipple induces an eddying in the neighbourhood of the welded joints which has a favourable effect on the heat transmission; the loss in pressure is practically negligible.

THE REGULATION OF THE GENERATOR.

The following considerations show that the regulation of the single-tube steam generator, *i.e.*, adjusting the rate of steam raising to suit the momentary requirements of the service, and particularly to ensure that the final temperature of superheat always remains unchanged, may be no easy task.

With a tube 1300 m. long a particle of water requires 8⅜ minutes from the time it enters the tube until it issues at the other end in the form of steam. If the rate of steam raising is halved the time required for the particle to traverse the tube is increased to 17 minutes. Hence a considerable lag before a change in the rate of feed produced an effect might be anticipated. Fortunately, that is

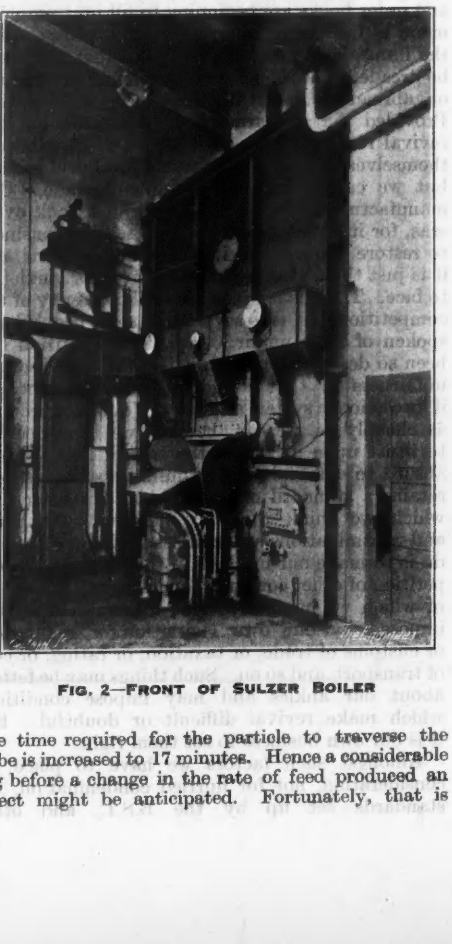

FIG. 2—FRONT OF SULZER BOILER

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* Translated and abridged.

not the case. A sudden increase in the feed pump pressure, for example, is transmitted almost instantaneously to the spot where evaporation begins, since the " wave " passes through the " solid " water column filling the preheating zone with the "velocity of sound," about 1000 m./sec., and the velocity of flow is consequently correspondingly increased. Hence more water at once begins to evaporate, and the steam requires, in the case under consideration, only 37 seconds to reach the end of the tube, when the boiler is working fully loaded. Finally the quantity forced into the tube by auxiliary injection at the spot where superheating begins requires only 13 seconds to traverse the rest of the tube with the boiler working at full load. But even this time lag, compared with the instantaneous restoration of balance by the turbine governor, is quite considerable. Hence means had to be devised to effect closer regulation.

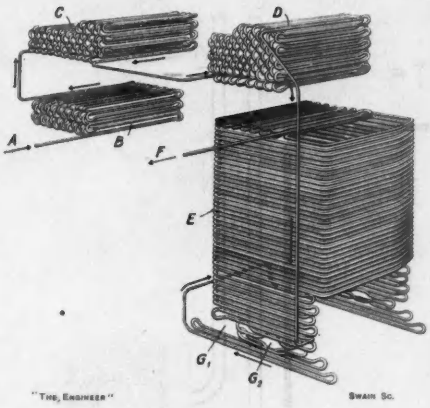


Fig. 3—Tube Arrangement

A—Feed water inlet.
B, C—Preheating zone.
D—Zone of intensive evaporation.
E—Heating surface subject to radiation.
F—Outlet for superheated steam.
G_1, G_2—Openings for inspection.

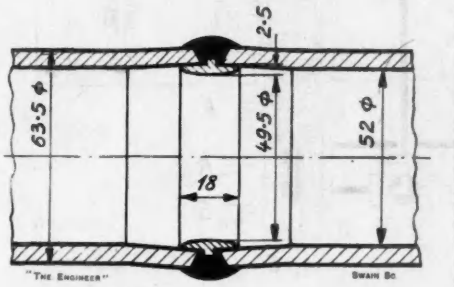


Fig. 4—Welded Tube Joint

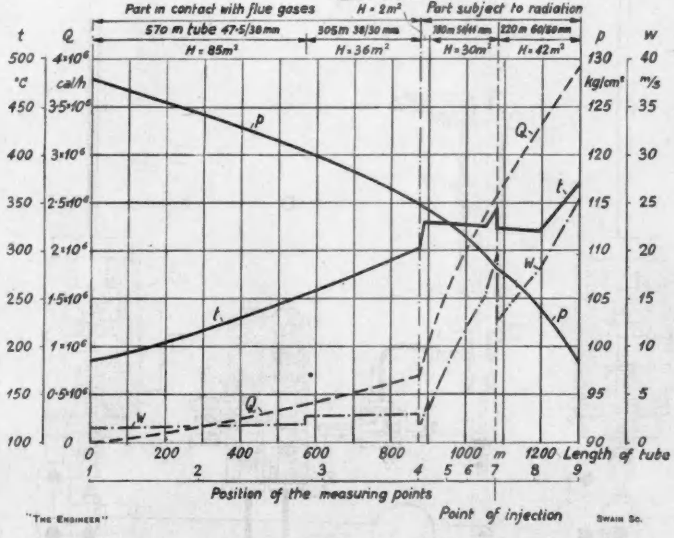


Fig. 5—Curves of Pressure, Temperature, Speed, and Heat

Boiler working at about 100 atm. gauge and raising 7·28 tons of steam per hour.
(Quantity of injected water = 1·97 tons per hour.)

t—Temperature of water or steam.
p—Pressure in atm.
W—Speed of water or steam.
Q—Quantity of heat introduced.
H—Heating surface.

Steam Supply Regulation.

The solution adopted for the regulation in the first generator was suggested to a large extent by the following fundamental considerations :—

(1) A change in the rate of steam raising has to be effected in such a way as to maintain the temperature at the outlet as constant as possible. Just as in a centrifugal governor, the drawback which has to be prevented must be allowed to occur to a certain extent, *i.e.*, the regulating devices can only be made to function when the final steam temperature exceeds or falls below the normal temperature by a certain amount. If then, for example, the upper limit of temperature is reached, a certain balance between the heat introduced and the momentary rate of steam raising may be obtained, and a further increase of the amount of feed water delivered would then mean " over-regulation." Delivery of feed water is consequently of the greatest importance during that regulating period, when there is an excess of heat introduced above what is required for the momentary steady rate of steam raising. Consequently, it is not only the excess temperature which is used to determine when regulation shall be effected, but also the differential quotient of that excess with regard to the time $= d\,T/d\,z$. For this reason the corresponding part of the regulating device is called a " differential regulator."

(2) It is, of course, self-evident that when the load on the boiler increases, the intensity of the firing must be increased as well as the quantity of feed water delivered. But the rate of steam raising, the intensity of firing, and the quantity of feed water are all functions of each other of a particular kind, and the regulating devices have to take account of this.

The type of construction adopted for the whole regulating arrangement is based on the general adoption of hydraulic control and hydraulic remote transmission, the reliability of which has long been recognised by the makers of steam turbines.

The principal organs of the regulating apparatus are the following :—

1. *Remote Temperature Indicator.*—The difference in expansion between a straight tube, 2600 mm. long, projecting outwards, and an equally long rod of Invar steel (with a coefficient of expansion of about 10^{-6}), which is subjected to the temperature of the boiler-room, is transmitted, as shown in Fig. 6, to a control apparatus, in the upper part of which a "pulsating" movement is produced. The face *g* of the valve B connected with A is under the influence of pressure fluctuations between 0 and 10 atm., so that the valve, by means of the back-pressure face *f*, is caused to pulsate up and down ±0·3 mm. The valve A also follows the motion of the end of rod F and operates by means of levers G and L the control valve N, and by means of N the piston S fitted with usual compensating motion. Spring V presses valve U downwards, so that pressure oil forces its way through openings W into the space T until balance with the spring pressure is restored. R is the oil outlet, D the pulsator oil, 0 to 10 atm., P the pressure oil inlet, and E the regulating oil. The increase of pressure in the space T, as compared with the initial state, is therefore proportional to the distance passed through by the end of the rod F, *i.e.*, proportional to the increase in temperature above the normal. The "regulating oil," thus produced, is the working medium for the actual regulating members. The whole device is termed a " thermostat " by the makers.

2. *Differential Regulator with " Summation Valve " for Directly Influencing the Temperature*.— As mentioned above, the differential regulator has to control the quantity of feed water delivered in accordance with the rate at which the temperature rises, independently of the absolute height of the temperature, *i.e.*, approximately in proportion to $d\,T/d\,z$. This is effected by causing a piston to move up and down in accordance with the temperature, thus expelling or drawing in the contents of the cylinder through a throttle opening. The resulting oil pressure is very nearly proportional to the speed of the piston, and consequently also to $d\,T/d\,z$. How this result is realised in practice is shown in Fig. 7. Here the (temperature) regulating oil enters at A below the spring-loaded control valve B, which, when raised, allows pressure oil to pass by way of the tube *a* and then under the servo-motor piston C, which raises the piston D and brings the valve B back to its middle position by means of the compensating lever F. During this movement the pressure under D falls (even below atmospheric) in consequence of the throttling of the oil by the opening E. This fall in pressure is transmitted to the valve G, so that it—by the spring H—lowers the valve J and allows pressure oil to flow past the edge K into the space L until the oil pressure rise in L has compensated the fall in pressure on G and brought the valve J back into the middle position. R is the oil outlet, S the pressure oil inlet, P the regulating oil from thermostat, and T the regulating oil to control valve of feed water regulator.

The influence of the absolute height of the temperature is at the same time made effective in a very ingenious manner, the same regulating oil as at A being led also to the piston M in the space N, so that with the help of the springs H and H_1 the control valve J may be at the same time influenced independently, and can cause a corresponding rise in pressure in L. The pressure in L is consequently at all times the sum of the temperature regulating pressure and the (algebraic) value of the pressure changes caused by $d\,T/d\,z$ in the space below D. The part composed of M H G J is therefore rightly named " summation valve."

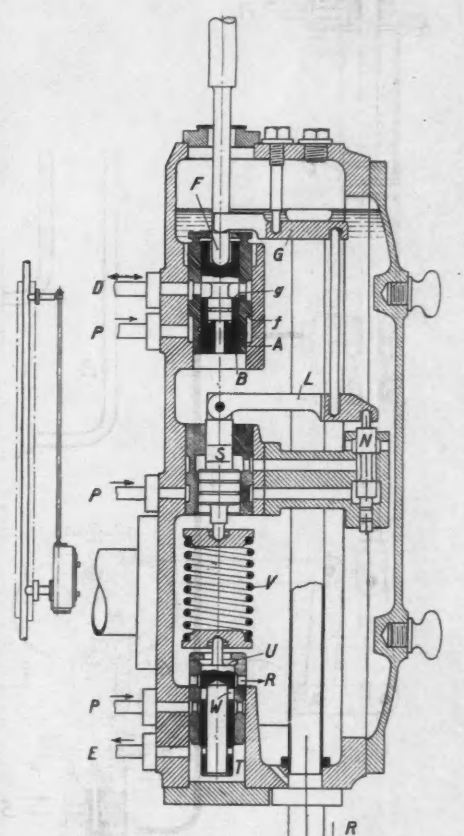


Fig. 6—Remote Temperature Indicator

3. *Injection Regulator with Positive Compensating Motion* is shown in Fig. 8. The regulating needle A, which is in the form of a sharply tapered cone and allows the feed water to pass through the pipe B to the injection point, is raised and lowered by the long-stroke servo-motor piston C, which is controlled in the usual manner by the valve D. The piston is lowered by the needle pressure and an additional weight, so that pressure oil is necessary only for raising the piston. On the lower face of the control valve D, the regulating oil of the temperature indicator acts at E. The total pressure acting on the lower face of the valve (neglecting the weight of

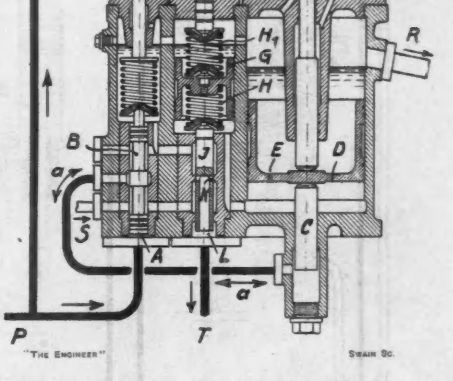


Fig. 7—Differential Temperature Regulator

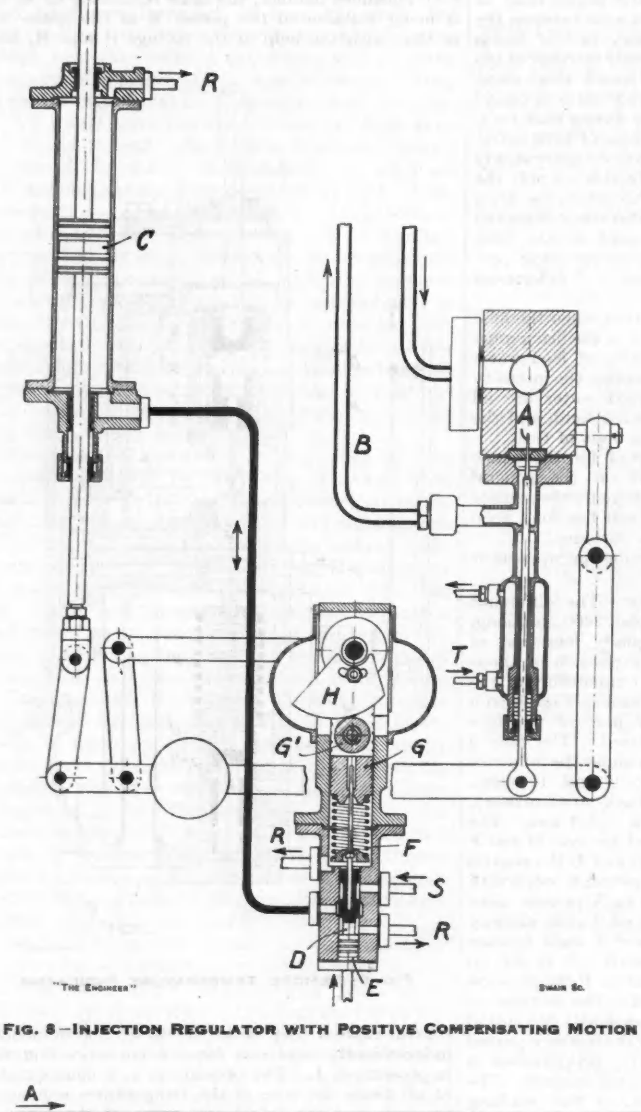

R
C
B
A
T
H
G'
G
R
F
S
D
R
E
"The Engineer"
Swain Sc.

FIG. 8—INJECTION REGULATOR WITH POSITIVE COMPENSATING MOTION

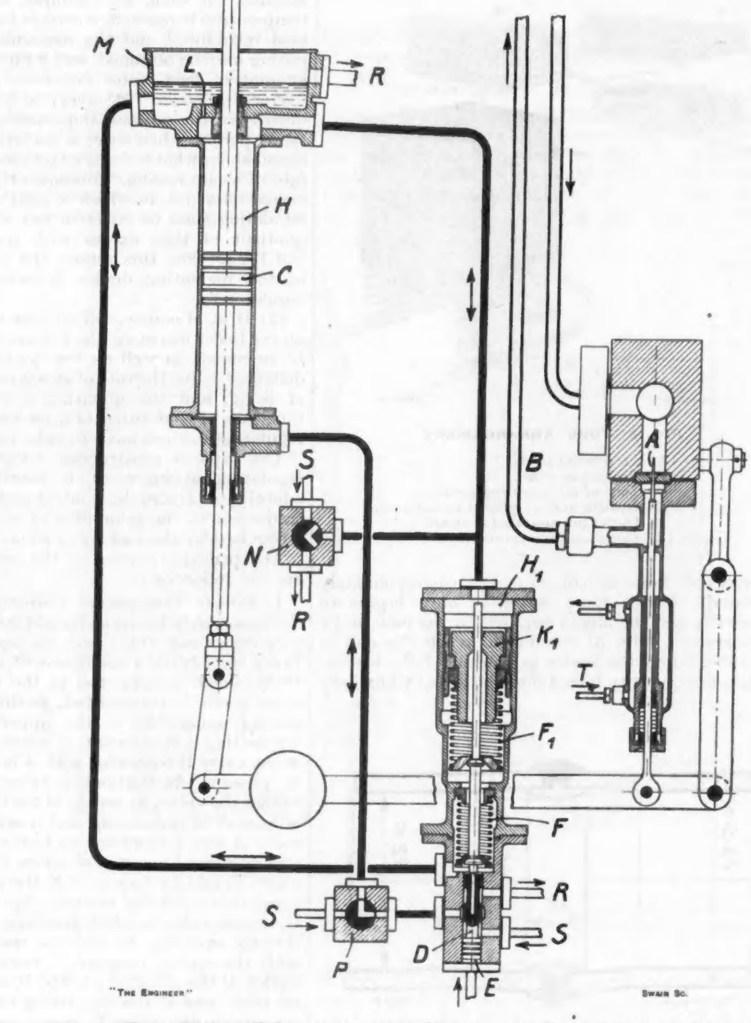

M
L
R
H
C
B
A
S
N
R
H₁
K₁
T
F₁
F
R
S
P
D
S
E
"The Engineer"
Swain Sc.

FIG. 9—FEED-WATER REGULATOR WITH ISOTHERMAL COMPENSATING MOTION

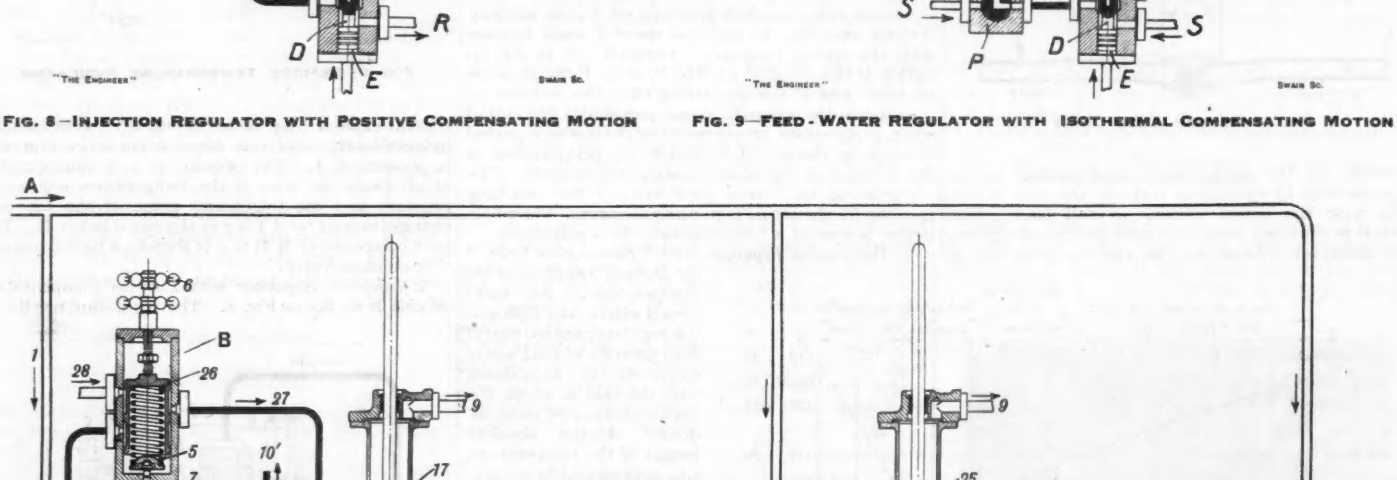

A
1
B
6
28
26
27
5
10'
4
7
10
8
9
3
2
3'
4'
9
17
16
C
13
12
9
14
8
9
15
11
18
9
25
24
D
20
29
19
9
22
8
8
23
21
27
10
10
"The Engineer"
Swain Sc.

FIG. 10—PRESSURE REGULATION

A—Steam pipe from boiler.

1 —Connecting pipe for steam pressure.
2 —Plunger.
3 —Valve.
3'—Vessel filled with cylinder oil.
4 —Rod.
4'—Oil make-up.
5 —Spring.
6 —Hand wheel.

B—steam pressure receiver.

7 —Regulating oil space.
8 —Pressure oil pipe.
9 —Outlet.
10'—Pulsator oil pipe.
11 —Regulating oil from thermostat.
12 —Control valve for turbine valve.
13 —Safety valve
14 —Annular space.

C—Turbine valve.

15 —Cock.
16 —Space under servo-motor piston.
17 —Servo-motor for turbine valve.
18 —Steam pressure regulating valve.
19 —Control valve for by-pass valve.
20 —By-pass valve.
21 —Starting valve.
22 —Annular space.

D—By-pass valve.

23 —Cock.
24 —Space under servo-motor piston.
25 —Servo-motor.
26 —Hand-operated valve.
27 —Connecting oil pipe.
28 —Pressure oil inlet.
29 —Pressure oil inlet.

the valve itself, which is slight) is taken by the spring F, which is held against the cam H by means of guide piston G and roller G^1. When the servo-motor piston C falls, the valve is brought back into the middle position by means of the cam H, the pressure of the spring being increased. R F is the oil outlet, S the pressure oil inlet, and T the cooling water inlet.

4. *Feed-water Regulator with Isothermal Compensating Motion* is shown in Fig. 9. A slightly tapered regulating needle A allows the excess feed water to pass through B into the suction piping, when the feed pump, as in the present plant, is set to deliver a fixed total quantity. The serve-motor piston C is controlled by the valve D, the combined pressure coming from the differential regulator acting on its under face at E. With an increase in the feed-water delivery, the return motion is effected through the oil forced by the servo-motor piston C upwards out of H towards H_1. This oil presses the valve D back into the middle position by means of piston K_1 and spring F_1. Spring F and the spring F_1 loaded by the piston K_1 serve to compensate the regulating oil pressure in E. For isothermal action the throttle opening L is essential. It allows the spring F_1 to expand, thus causing a renewed raising of D and C, and also an increase in feed-water delivery, *i.e.*, a temporary over-regulation. In consequence of the fall in temperature which now takes place, the pressure at E will fall and the temperature, after some fluctuations, will return to its initial value when the oil brake is properly adjusted. The spaces round F and F_1 are connected to the collecting vessel M for the removing of any oil which oozes out. N, P = cocks for adjusting the feed-water regulator by hand; R = oil outlet; S = pressure oil inlet; T = cooling water inlet.

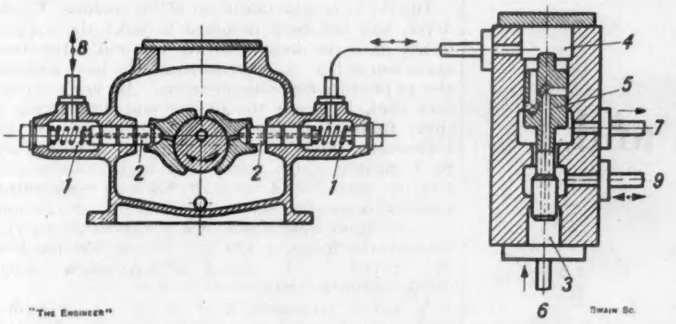


FIG. 11—PULSATOR

1, 4—Pulsating oil column.
2—Plunger.
3—Pressure-oil space.
5—Vibrating valve.
6—Pressure-oil connection.
7—Oil outlet.
8—Pulsator oil pipe for steam-pressure controller.
9—Pulsator oil for thermostat (0 to 10 atm.)

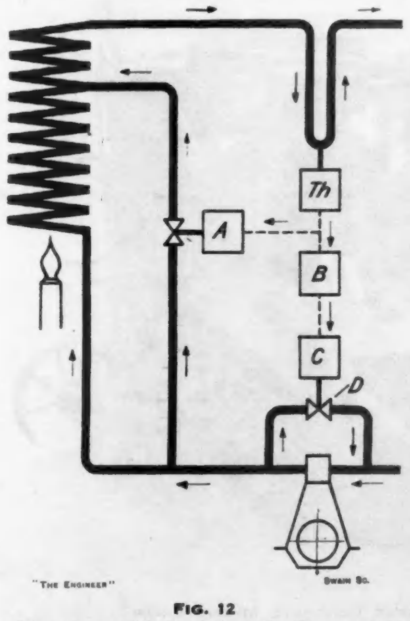


FIG. 12

General Arrangement of the Regulation with a Thermostat at Steam Outlet.

A—Injection regulator with positiye compensating motion.
B—Differential regulator.
C—Feed-water regulator (isothermal).
D—By-pass valve for feed water.
Th—Thermostat.

5. *Injection Regulator with Isothermal Compensating Motion.*—This regulating device, which was used during the tests described below, may also be considered as described by Fig. 9, when one imagines the injection to be below A and the inlet and outlet for the pressure oil on the valve casing to be interchanged in the manner shown in Fig. 8, the influence of the compensating motion being also altered appropriately.

6. *Appliance for Hand Control of the Regulation.*—Simple cocks allow the servo-motor to be connected alternately with the pressure oil piping and the oil outlet. Thus, for example, the cock marked N in Fig. 9, when turned through 45 deg. in a counter-clockwise direction, serves to connect the upper side of the servo-motor piston with the pressure oil. The oil forces the control valve downwards, and this, in turn, causes the servo-motor piston to fall, in consequence of its underside being connected to the outlet. The quantity of feed water delivered to the boiler is consequently reduced. The contrary takes place when the cock is turned through 45 deg. in the clockwise direction.

If the cock marked P in Fig. 9 is turned through 90 deg. in a counter-clockwise direction, the servo-motor piston passes quickly into its highest position, and the quantity of feed water delivered to the boiler is thus set at its maximum value. The cock may also be turned into the same position when the generator is being stopped, if it is considered necessary to cool the tubes and the boiler setting quickly.

The injection regulation with isothermal return motion may also be operated by hand in a similar manner.

7. *Pressure-regulating Device.*—In the plant tested at the works of Charles Weber, Ltd., Winterthur, the pressure in the generator is regulated to remain constant, and it was necessary, in addition to the "turbine valve" controlling a turbine, to fit a "by-pass valve," which leads the steam direct to the high-pressure condenser. Because of the method described below for starting and stopping the generator, it is not possible to dispense with this by-pass valve even in ordinary power plants.

The essential parts of the pressure regulation (Fig. 10) are: The pressure receiver, the steam pressure regulating valve 18, and the by-pass valve 20. The method in which they work is as follows:

The steam pressure on the piston face of the plunger 2 is transmitted to the valve 3, and through the rod 4 to the spring 5. Its height is adjusted by changing the spring tension by means of hand wheel 6. In space 7, and in regulating oil pipe 10, an oil pressure proportional to the steam pressure is produced.

The safety valve 13, during normal service, remains in its top position, so that the middle space 14 of control valve 12 is connected with the space 16 of the servomotor 17 through cock 15, which, in the figure, is shown in its working position. With increasing oil pressure in the system 10, *i.e.*, with increasing steam pressure, the steam pressure regulating valve 18 leading to the turbine is opened, and with falling oil pressure closed. The starting valve 21 is, in normal service, kept in its top position by pressure oil from pipe 28, so that space 22 of the control valve 19 is connected with space 24 of the servo-motor 25 through cock 23. When starting, valve 26 connects pipe 27 with system 10. Therefore, if the steam pressure is still insufficient, valve 21 is in its lowest position, so that the pressure oil entering through pipe 29 opens the by-pass valve 20 completely.

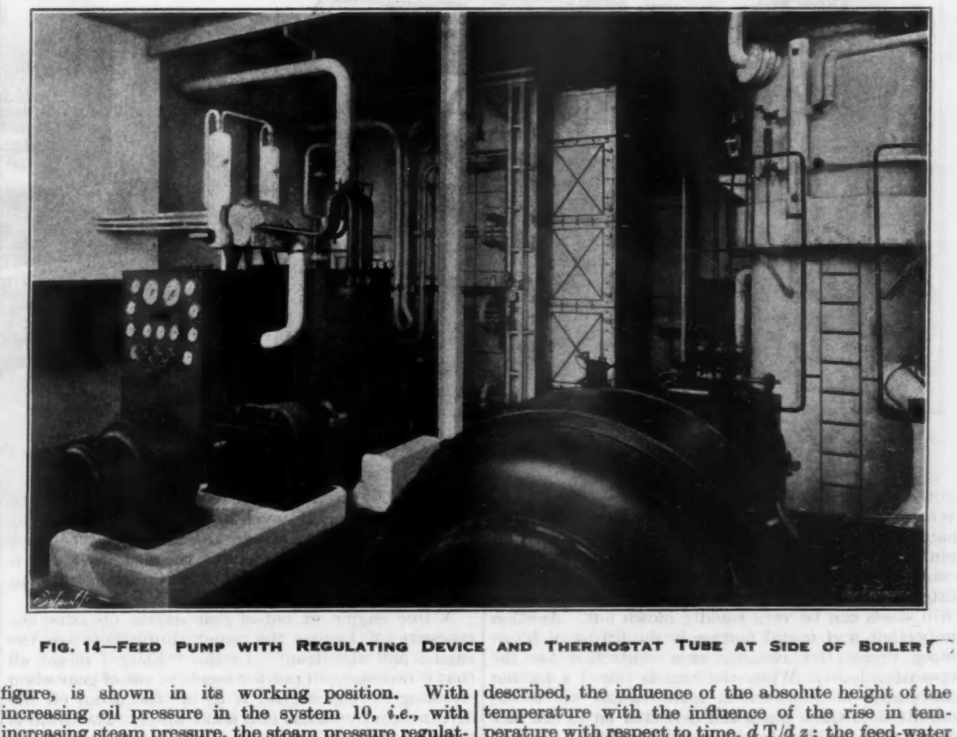


FIG. 14—FEED PUMP WITH REGULATING DEVICE AND THERMOSTAT TUBE AT SIDE OF BOILER

Valve 13 is intended to protect the turbine from too low temperatures, *i.e.*, from water hammer. For this purpose the regulating oil from the thermostat acts on the lower face of the piston. If the temperature sinks below about 350 deg. Cent., the valve falls and connects the servomotor piston space 16 with the outlet, whereby the turbine valve 18 is closed.

8. *Pulsator, i.e.*, the necessary device for maintaining a continuous slight fluctuation in pressure in all parts of the regulating device is shown in Fig. 11. The oscillations of all movable parts constantly caused in this manner, makes them respond more quickly to the slightest change in the mean pressure, and almost entirely eliminates the risk of any member seizing.

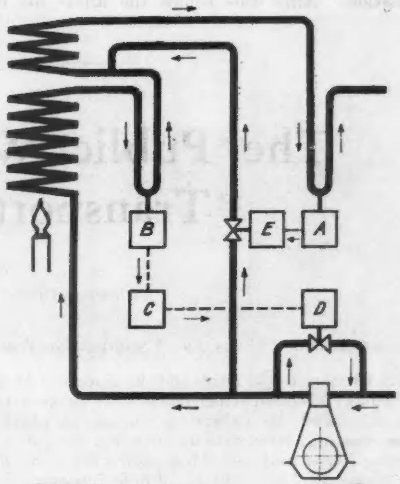


FIG. 13

General Arrangement of the Regulation with a Thermostat at Steam Outlet and an intermediate Thermostat before the Injection Point.

A—Thermostat at end of tube.
B—Intermediate thermostat.
C—Differential regulator.
D—Feed-water regulator (isothermal).
E—Injection regulator (isothermal).

COMPLETE ARRANGEMENT OF THE REGULATING DEVICE WITH A THERMOSTAT AT THE STEAM OUTLET.

The regulating parts just described may be grouped together in various different ways. The arrangement shown in Fig. 12 is that which is chosen for ordinary power plants with many prime movers and steam generators, where the load variations do not as a rule exceed more than 20–30 per cent. of the maximum output of one unit.

Here the end thermostat Th acts directly on the injection regulator A, which works with mechanical compensating motion, and also on the differential regulator B. In the latter are combined, as already described, the influence of the absolute height of the temperature with the influence of the rise in temperature with respect to time, dT/dz; the feed-water regulator C, which is set for a constant temperature, is thus operated. D is the by-pass valve for the feed water.

COMPLETE ARRANGEMENT OF THE REGULATING DEVICE WITH A THERMOSTAT AT THE STEAM OUTLET AND AN INTERMEDIATE THERMOSTAT BEFORE THE INJECTION POINT.

Fig. 13 shows the arrangement intended for regulating plants in which importance is laid on the closest regulation, even with great and sudden fluctuations in load. As can be seen, in addition to the end thermostat A, an intermediate thermostat B is arranged directly before the injection point. From the intermediate thermostat the regulating oil controls the differential regulator C, which is connected with the summation valve controlling the feed-water regulator D. The feed-water regulator is under the combined influence of the absolute height of the intermediate temperature T and its variation according to time, dT/dz. The regulating parts B C D, since they are subject to the great time lag in the long tube, constitute a kind of pre- (or coarse) regulation. After this comes the after- (or fine) regulation by means of the injection regulator E, which acts in this case with isothermal compensating motion. Since the steam flowing towards the injection regulator has already been treated, the regulator must act more promptly and therefore a very complete balance of temperature may be expected in a very short time.

As shown in Fig. 14, these regulating parts can be brought together into a box which takes up very little room (as can be seen from the measuring apparatus). The looped tube of one of the thermostats can be seen in the background.

(To be continued.)

The Public Works, Roads, and Transport Exhibition.

No. II.

(Continued from page 456, November 10th.)

The Climax Rock Drill and Engineering Works.

The Climax Rock Drill and Engineering Works, Ltd., of 4, Broad-street-place, with works at Carn Brea, Cornwall, are exhibiting pneumatic plant for stone dressing, rock drilling, digging, &c., and for dressing kerbs and setts, together with some drill-sharpening machines and an oil-fired furnace.

We illustrate one of the smaller sizes of drill sharpeners in Fig. 21. This machine has been designed to meet the needs of the smaller mine, quarry, or contractor, where jack-hammer drills are used and bits not exceeding 2⅝in. in diameter are required. The swaging ram is operated by an air cylinder in the base, and is pulled down by side rods. The ram also acts as a gripping vice. The dollying hammer is mounted on the same base, at right angles to the swaging ram, and faces the operator. In addition, to the right of the dollying hammer, there is a knock-in and knock-out pin punch, for opening out the hole in the shank or bit on hollow drill steel. The punch is fed forward by an air feed and at the same time it is hammered into the hole of the steel. When the desired depth has been reached, it is hammered out by reversing the control lever. A pin puller is fitted at the side of the machine, and is controlled by a foot lever. A blow-out device is fitted to the front of the machine by means of which drill steels can be very rapidly blown out. Another important and useful feature is the fitting of blowpipes under the swaging ram controlled by the operating lever. When the ram is raised a further movement of the control lever causes air to be admitted to these pipes and deflected on to the face of the dies, rapidly clearing away the scale.

The operation of the machine is controlled by a single lever. A slight movement of this lever closes the swaging ram on the steel stock. A further movement brings the dolly hammer into operation, and on release of the lever the dolly hammer ceases operation. When used for swaging, the ram gives any number of sharp, quick, but powerful blows, by means of short movements of the operating handle. The dolly is retained in the dolly cylinder by means of a plunger acted upon by air pressure, thus obviating the use of springs, which are a constant source of trouble. The weight of the machine is about half a ton, and it requires 55 cubic feet of free air at a pressure of 80 lb. per square inch.

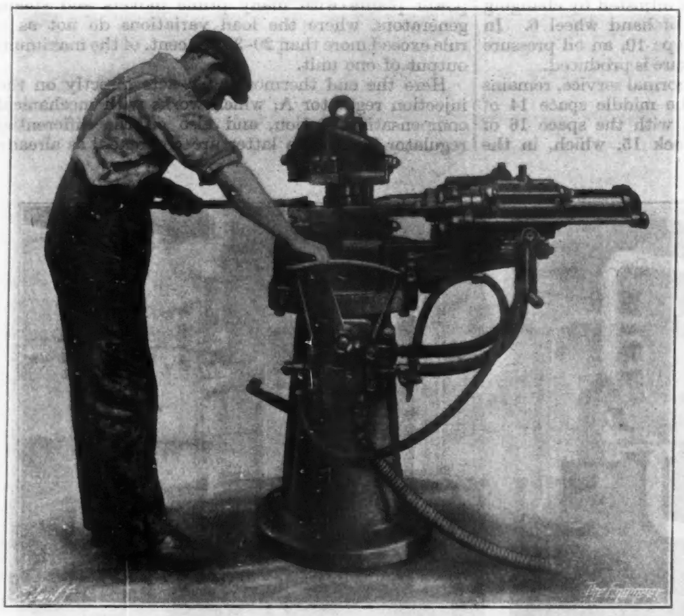


Fig. 21—Rock Drill Sharpener—Climax

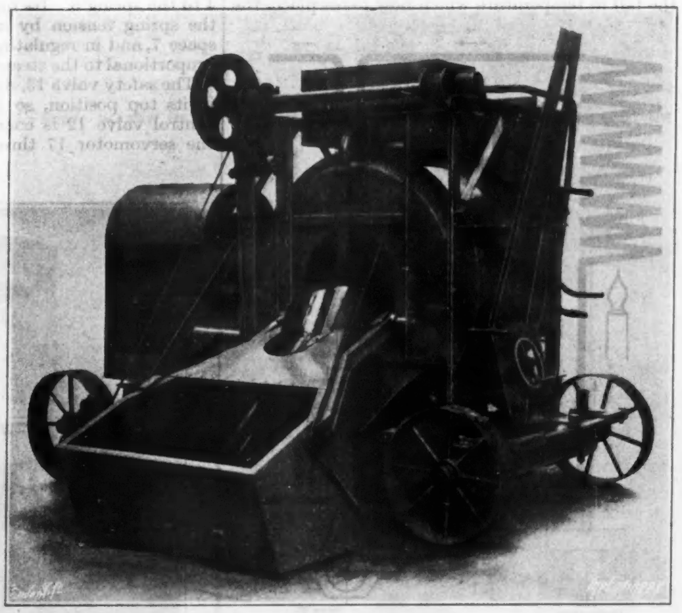


Fig. 22—Portable Concrete Mixer—Liner

The Liner Concrete Machinery Company.

For the first time the Liner Concrete Machinery Company, of Glasshouse Bridge, City-road, Newcastle-on-Tyne, is showing a concrete mixer of the rotary drum type. It is illustrated by Fig. 22. There are, however, mixers of other types on this stand.

The rotary drum mixer has a capacity of 10/7 cubic feet, and is, it will be seen, of the portable type. It is driven by an enclosed petrol engine. One of the outstanding features of the machine is the arrangement for carrying the drum, which is mounted on four rubber-tired rollers, two of which are driven by the engine through machine-cut gear wheels. This method of mounting and of driving the drum has the advantage that it dispenses entirely with the customary gear ring or chain wheel round the drum, thus enabling the drum to be readily removed from the machine. A smooth, even and silent rotation of the drum is obtained with no metal-to-metal contact, and with no external wear of the drum. There is also less noise, which means less vibration and consequently less wear.

A free engine or out-of-gear device obviates the necessity of having the usual clutch between the engine and the drum. In the "Liner" mixer all that is necessary to put the machine out of gear when cranking up the engine, is to lift the drum off the driven tires by means of a hand wheel. The drum is then lowered on to the revolving tires and immediately starts to revolve.

The direction in which the control lever of the hopper-raising gear is moved for the in-gear or hoisting position is directly opposite to that for the lowering position, instead of the lowering position being, as usual, half-way between the hoisting and the braking position. The effect of this is to dispense almost entirely with the gap or period when the hopper is out of control when changing from hoisting to lowering, and *vice versâ*. Safe and smooth working results without necessity for fine adjustment, and wear and tear is reduced.

Millars' Machinery Company, Ltd.

The most novel exhibit on the stand of Millars' Machinery Company, Ltd., Pinners' Hall, London, E.C.2, is the plant, illustrated by Fig. 23, for making tarmacadam, bituminous macadam, and asphaltic road surfacing mixtures. It has the outstanding feature that it can be worked at widely different temperatures, and consequently will do the work for which two plants are usually necessary. It has a capacity of 10 tons per hour.

The dryer is a modification of the makers' T.B.M. dryer, and has been designed to meet the requirements of users manufacturing tar and bituminous macadam at low temperatures and who have occasion also to produce asphaltic mixtures. By low temperature work is meant the drying and discharging of stone from 2½in. down at a temperature varying between the limits of 90 deg. Fah. and 120 deg. Fah., the capacities stated being based on a moisture content not exceeding 4 per cent. By high temperature work is meant the drying, heating, and discharging of stone from 2½in. down at a temperature varying between the limits of 400 deg. Fah. to 450 deg. Fah. The output stated is based on a moisture content not exceeding 6 per cent.

A special arrangement of lifting and propelling blades fitted inside the drying drum ensures that graded material can be passed through and discharged with very little variation from the initial grading, this variation usually not exceeding 1½ per cent. The design allows the fine material, *i.e.*, ⅛in. and down, to be retained in the drum and discharged with the larger stone. Alternatively, all dust can be extracted by means of special doors fitted at each end of the dryer, and collected, if need be, in a cyclone type dust collector.

On the low temperature work the dryer operates on the "parallel-flow" system, the drying being effected by means of large volumes of warm air drawn down the drum by a large fan. The air enters the dryer through adjustable inlet ports and intermingles with the hot fuel gases as it passes down the drum. The inlet ports are adjustable so that any quantity of air can be introduced to the dryer in addition to that delivered through the secondary air ports arranged for the combustion of the oil fuel. With this arrangement a great variation in the adjustment of the burner is possible, enabling the burner to operate from a quarter open to full open to suit the moisture content and the terminal temperature required. Strict uniformity of temperature is a noteworthy feature of this arrangement.

On high temperature work the dryer operates on the "contra-flow" principle, the drying and heating of the stone being effected by introducing the hot gases into the dryer at the discharge end instead of at the feed end. They pass out at the feed end of the dryer by means of the same exhaust fan. This arrangement ensures that the aggregate is dried at the cooler end of the drum and then passes through the hottest gases as it is discharged. The one exhausting fan is employed for reasons of economy, but the feed and discharge ends are connected to the fan by means of ducting, and dampers are provided so that the fan can draw either from the feed end or discharge end according to whether the high or low temperature process is in operation.

The apparatus for controlling the discharge of the dust consists of special doors fitted in the discharge chambers at each end of the dryer. The effect of opening either of these doors is to increase the velocity of the gases passing through the dryer, thus drawing off the lighter dust. If both doors are kept closed, all the fine material is retained in the drum. The combustion chambers are each provided with cleaning doors, through which a straight-through raking tool can be used.

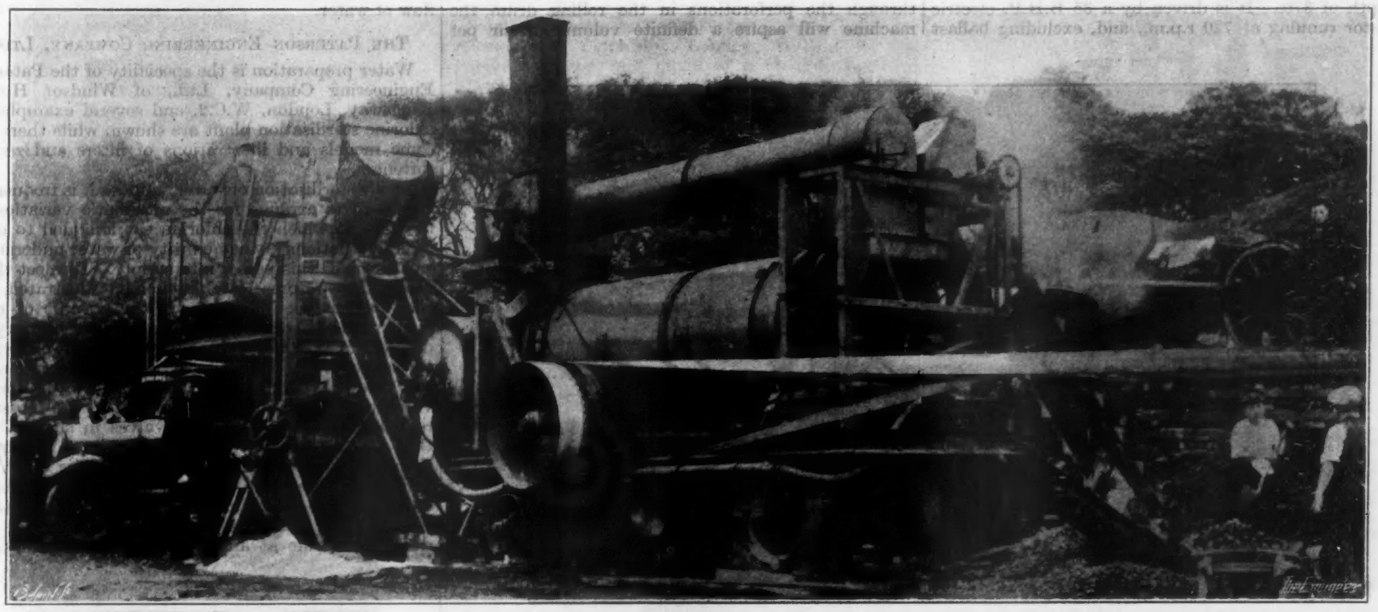


FIG. 23—PLANT FOR MAKING TAR-MACADAM AND ROAD-SURFACING MIXTURES—MILLARS

The combustion chambers are constructed of steel plate stiffened with steel angles. The feed end chamber is arranged to receive the feed spout and the discharge end chamber is provided with a discharge hopper built of steel plate and fitted with a discharge door of the gate type. At each end of the plant the upper portion of the combustion chambers is arranged to receive the steel ducting connecting up to the fan. The combustion chamber at the feed end is fitted with a special fire-brick chamber to suit the oil burner, and the chamber at the discharge end, being larger, is lined with fire-brick. Each combustion chamber is fitted with one oil burner—a No. 10 size at the feed end and a No. 20 size at the discharge end. Under certain conditions it is necessary for the feed end burner to be fitted alongside the No. 20 burner at the discharge end in order to secure the necessary temperatures. The oil is atomised by compressed air at a pressure of 3 lb. per square inch, the air being derived from a blower mounted on the main frame. A fuel oil supply tank is mounted on the main frame, with a fuel level indicator and semi-rotary hand pump for filling. The oil is delivered to the burner at either end of the dryer under a pressure of 4 lb. per square inch, the air being taken from the blower which also supplies the air for the atomisation of the oil. The tank is completely covered and is readily accessible.

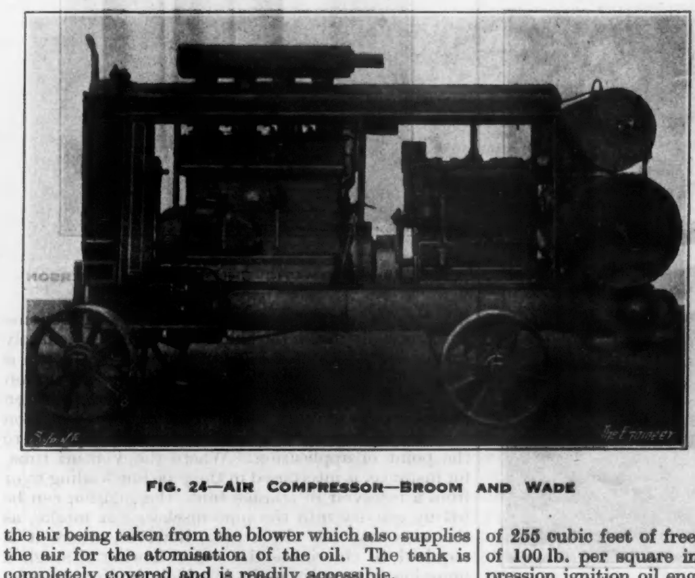


FIG. 24—AIR COMPRESSOR—BROOM AND WADE

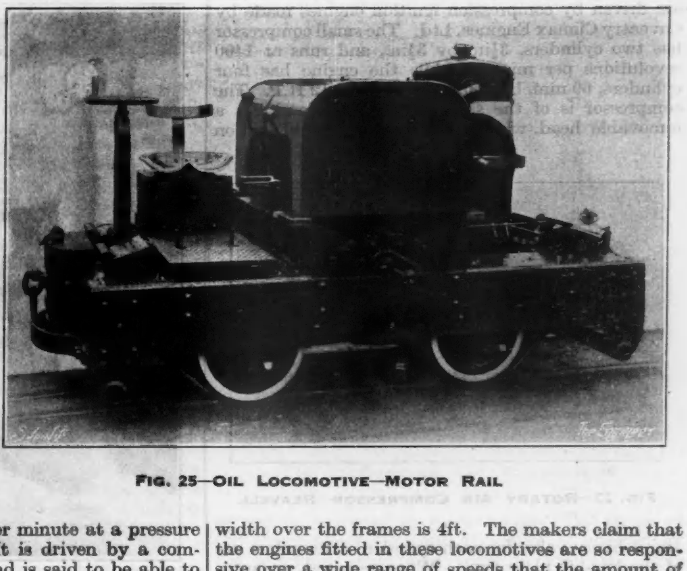


FIG. 25—OIL LOCOMOTIVE—MOTOR RAIL

The drying drum is 4ft. in diameter by about 12ft. long and is constructed of steel plate, ¼in. thick, fitted with steel lifters and semi-diaphragm plates for breaking up the flow of the gases. It is mounted on cast steel tyres and supported on cast iron rollers fitted with gun-metal bushes mounted on steel axles. The axles are provided with adjusting screws to facilitate the alignment of the drum and to ensure smooth working. Vertical thrust rollers are fitted at the feed end to ensure that all expansion of the drum is passed on to the discharge end. The drum is lagged with asbestos mattresses and covered with light steel sheeting to protect the lagging from the weather. The fan is of the centrifugal type and driven by a Renold chain and sprockets from the main countershaft of the plant.

The feed elevator is of the intermittent type with buckets of malleable iron. A small hopper built of steel plate is arranged to take the discharge from the dryer and is fitted at the lower end with a hinged balanced closing door so that the dried material can be retained in the hopper as desired and be discharged at will into the loading skip of the mixing unit or into the boot of a hot elevator.

The chassis of the stationary model is fitted with cast iron cup and ball bearings at the discharge end, while the feed end has cast iron brackets provided with cast iron wedges, by means of which the inclination of the dryer can be varied to suit the material being dried. The portable model is mounted on four road wheels having steel treads, steel centres, and heavy cast iron hubs. The axles are of mild steel turned from the solid, and the front axle is mounted on a swivelling forecarriage and provided with draw gear. The machine requires about 15 horse-power.

On this stand there are also some concrete mixers, trucks, and other contractors' plant.

BROOM AND WADE, LTD.

A new air compressing unit is being shown on the stand of Broom and Wade, Ltd., High Wycombe. It is illustrated by Fig. 24, and has an actual delivery of 255 cubic feet of free air per minute at a pressure of 100 lb. per square inch. It is driven by a compression ignition oil engine, and is said to be able to run for a full eight-hour day at a cost of only 9s. for fuel and lubricating oil, which is about a quarter of the running cost of a similar petrol-driven set.

The compressor is of the makers' sleeve valve type, which we have described in the past, and has three cylinders, 6¼in. bore by 5¼in. stroke. It runs at a speed of 1000 revolutions per minute, and has a piston displacement of 303 cubic feet per minute. There is an air governor for unloading the compressor when the working pressure is reached, and an air receiver, 2ft. in diameter by 3ft. 9in. long. It is tested to a pressure of 190 lb. per square inch, and is equipped with the usual fittings. The aftercooler pipe is fitted with four cocks for ¾in. hose.

The engine is a Ruston four-cylinder set of 70 horse-power, and has both hand and compressed air starting gear. The drive is direct through an automatic centrifugal clutch. Air filters are fitted to the intakes of both the engine and the compressor. One radiator is used for cooling the engine and compressor, but the two units have separate pumps. A sheet steel housing is provided with detachable sides. The weight of the complete plant is about 4 tons 6 cwt.

There are half a dozen other air compressors on this stand, ranging from 20 cubic feet per minute upwards, and a collection of pneumatic tools.

MOTOR RAIL, LTD.

Three oil-engined locomotives are to be seen on the stand of Motor Rail, Ltd., Simplex Works, Bedford, one of which we illustrate in Fig. 25. They are intended for working on 2ft. gauge railways, and are of 2½ tons weight. One is equipped with a 12–16 B.H.P. compression ignition engine, another with a 20–28 horse-power engine, while the third is an old-type Simplex petrol locomotive which has been re-equipped with a high-speed British oil engine.

The locomotive which we illustrate has a wheel base of 3ft. 4in., and an overall length of 9ft. 0¼in. The wheels are 1ft. 5¾in. in diameter and are all drivers. The final transmission of the drive is effected by chains. The height to the platform, above the rails, is 1ft. 8½in., and the rail clearance 2¾in. The total width over the frames is 4ft. The makers claim that the engines fitted in these locomotives are so responsive over a wide range of speeds that the amount of gear changing necessary is reduced to a minimum. The radiators are the "Davies" detachable tube type, and are unaffected by vibration and shocks, and can readily be dismantled in case of damage.

STOTHERT AND PITT, LTD.

There are several appliances on the stand of Stothert and Pitt, Bath, which are somewhat novel, and among them there is the excavator illustrated in general arrangement by Fig. 26, which shows a larger size of the same machine.

The actual machine at the Show has an output of 30 cubic yards per hour, dependent on the material to be handled, and is capable of excavating to a vertical height or depth of approximately 14ft. The ladder can, however, be increased in length to dig a height or depth of 20ft. It is driven by a twin-cylinder Lister oil engine of 9½ H.P., running at 750 r.p.m., and the weight of the total equipment is approximately 8 tons *ex* ballast. The machine shown in the accompanying illustration is one of a larger size, capable of digging 60 cubic yards per hour actual output, and is shown working on gravel and sand. In this case the unit has to deal with a 7ft. depth of overburden, and is capable of digging a 30ft. vertical depth of gravel and sand, making a total vertical depth of 37ft. It is driven by a 35 B.H.P. electric motor running at 720 r.p.m., and, excluding ballast the approximate weight is 27 tons. This particular unit has excavated over 150,000 cubic yards of material, and on a number of occasions an output of over 100 cubic yards per hour has been recorded by the makers.

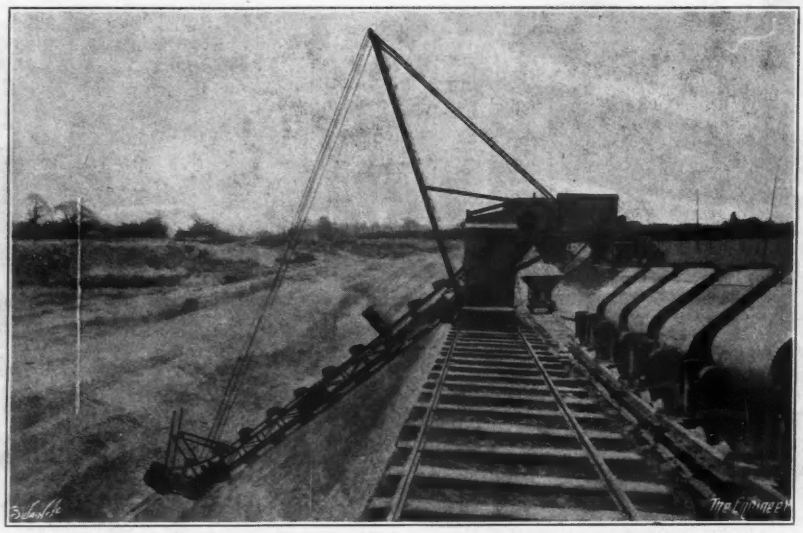


FIG. 26—MULTI-BUCKET EXCAVATOR—STOTHERT

There are also several other machines on this stand, including a vibratory screen which embodies, in addition to the vibratory action, an oscillating action produced by means of excentrics running in ball bearings in conjunction with spring suspenders. It is suitable for all screening problems, such as coal, coke, stone, &c., and can be designed for any output and number of gradings. Other machines include some concrete mixers, a hot mixer for tarmacadam work, and a portable telescopic mast and winch for general contracting work.

REAVELL AND CO., LTD.

A range of air compressors with capacities from 54 to 148 cubic feet is shown by Reavell and Co., Ltd., of Ranelagh Works, Ipswich, the newer types of which are driven by compression ignition engines made by Coventry Climax Engines, Ltd. The small compressor has two cylinders, 3¼in. by 3¼in., and runs at 1400 revolutions per minute, while the engine has four cylinders, 69 mm. by 100 mm. It gives 12 H.P. The compressor is of the single-acting type, and has a removable head, which contains a combined suction and delivery valve for each cylinder. The valves are of the low-lift plate type. When required, an automatic unloading device can be fitted. This unloads the compressor when the air in the receiver reaches the maximum pressure and reloads it when the pressure falls to a predetermined minimum. Immediately after unloading, air is admitted to a throttle control which automatically slows down the engine to an idling speed, and when the minimum pressure is reached the engine is again speeded up prior to the compressor being reloaded. This device results in a great saving of fuel and materially lengthens the life of the machine.

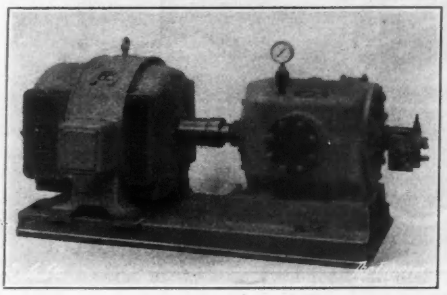


FIG. 27—ROTARY AIR COMPRESSOR—REAVELL

The rotary air compressor shown in Fig. 27 is of what is known as the rolling drum type, which avoids the wear of the rotating blades unavoidable in the old form of "crescent" compressor. Inside the bore of the casing there is a free drum, ground to fit accurately, and having a number of perforations. This drum runs in roller bearings in the end covers of the casing. Inside the rolling drum and running excentrically to it is an accurately machined rotor, provided with sliding blades in the usual way. When the rotor begins to revolve the centrifugal force generated in the blades causes them to press against the inner surface of the rolling drum, and the latter, being perfectly free to rotate, is at once carried round by the pressure of the blades. As air can pass freely through the perforations in the rolling drum the machine will aspire a definite volume of air per revolution and compress it just as positively and efficiently as if the blades pressed against the stator or casing itself. The shaft of the rotor is carried on ball bearings at each end, and as the only moving parts are the rotor and the rolling drum, which rotate on ball and roller bearings respectively, and the sliding blades, it will be realised that the mechanical efficiency of these machines is very high. These machines are made in several sizes for delivery pressures from 5 lb. to 20 lb. per square inch and for deliveries up to 2220 cubic feet per minute.

ELECTROFLO METERS COMPANY, LTD.

The most recent development shown by Electroflo Meters Company, Ltd., of Abbey-road, Park Royal, is the application of the electrically operated flow meter to the measurement of flows through Venturi flumes and over either rectangular or notched weirs. This meter, which we have described in the past, depends, it will be remembered, on the immersion of an electrical resistance in a bath of mercury, and the consequent variation in the current passing. In the original meter, the mercury is raised and lowered by a differential pressure round about a fixed resistance element, but in the new meter for flumes, which is illustrated by Fig. 28, the arrangement is reversed and a balanced float is used to raise and lower the resistance element in the mercury. An advantage of this arrangement is that the meter can be surmounted, as shown in the engraving, by a local height and rate of flow indicator.

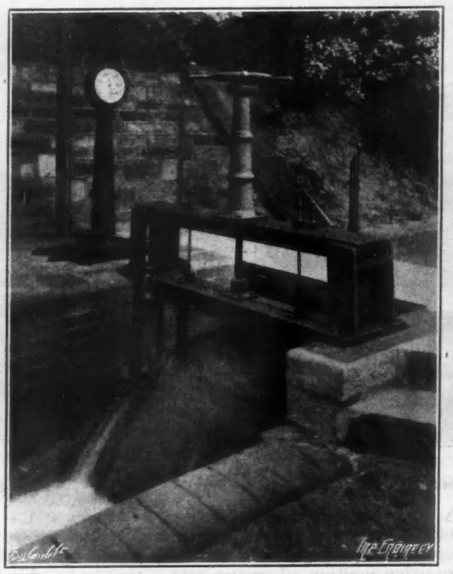


FIG. 28—FLOW METER—ELECTROFLO

Another quite recent development is the Electroflo Lineagraph. The main feature of this is a 12in. wide single-pen continuous recorder, which is driven horizontally across the full width of the chart. The chart has rectangular co-ordinates, and lasts for approximately three months, while the chart extension slide exposes a full unobscured record of one week's operation. It will be remembered that we recently reprinted in THE ENGINEER (April 21st, 28th and May 5th, 1933), a paper by Dr. F. V. A. E. Engel, of this firm, on his researches on non-uniform flow of water.

THE PATERSON ENGINEERING COMPANY, LTD.

Water preparation is the speciality of the Paterson Engineering Company, Ltd., of Windsor House, Kingsway, London, W.C.2, and several examples of chlorine sterilisation plant are shown, while there are some models and illustrations of filters and zeolite softeners.

In the sterilisation of water supplies it is frequently necessary to arrange for the automatic variation of the rate at which the chlorine gas is added to cope with fluctuations in the quantity of water undergoing treatment as this passes into supply. To meet these cases the automatic chloronome, illustrated by Fig. 29, has been devised for the purpose of controlling the chlorine flow by means of the varying differential head set up by a fluctuating flow of water through a Venturi tube. In the automatic chloronome this pressure difference is utilised to operate a special valve which combines the functions of the pressure-reducing and flow-regulating valves in such a way that an increase of water flow produces a proportionate increase of chlorine gas, and *vice versâ*. A particularly sensitive type of manometer indicates on a scale the rate of chlorine addition at any time. A regulating valve is provided for adjusting the dose of chlorine at any predetermined rate. Once this required dose has been decided, the chloronome automatically varies the chlorine flow proportionately to the flow of water. After measurement, the gas is passed through a moisture seal into an absorption tower, where it is converted into an aqueous solution discharged by gravity at the base of the absorption tower, and conveyed by chlorine-resisting piping to the point of application. Where the Venturi tube, for instance, is interposed in the pipe line leading to or from a reservoir or storage tank, the solution can be fed by gravity into the pipe discharge or intake, as the case may be. In a case, however, where it is required to chlorinate the water flowing through a pumping or pressure main, in which the Venturi tube is situated, as, for example, in the outflow from pressure filters, a pump of special design must, of course, be installed for injecting the chlorine solution against the head of water in the pipeline.

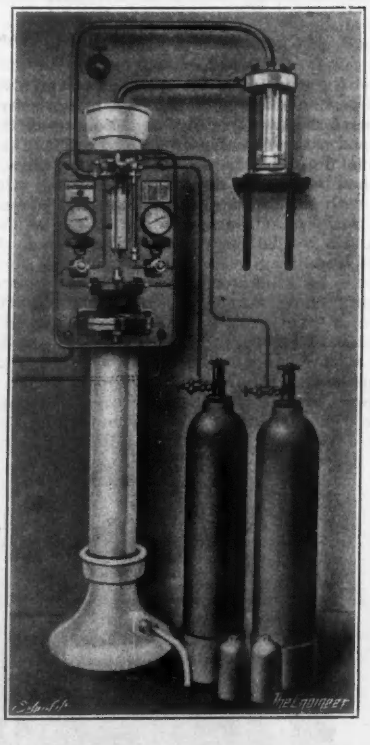


FIG. 29—AUTOMATIC CHLORONOME—PATERSON

A particular feature of the chloronome is the moisture seal interposed between the control panel and absorption tower. This seal, by preventing the entrance of moisture to the fittings on the control board, obviates any corrosion which would inevitably occur were the chlorine gas to become damp.

A recent development in this connection is a gaseous chlorine administrator combined with means for showing the actual quantity of chlorine being applied at any time, and giving a permanent record on a chart. The Chlorograph consists essentially of an orifice type flow meter connected to a glass "U" pattern manometer tube provided with a silvered scale which is calibrated to read the flow of chlorine in terms of the weight of the quantity of gas passing per hour. The recording mechanism consists of a special diaphragm chamber which is connected to the flow meter, and to a metallic aneroid cell. Fluctuations of pressure due to variation of flow through the meter are transmitted by means of a special liquid from the diaphragm chamber to the aneroid cell, and a pen arm coupled to this cell by a lever system records the variation of flow on a chart driven by a seven-day clock.

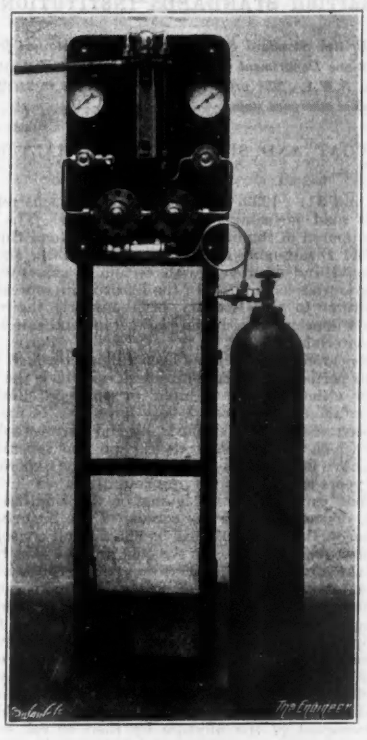


Fig. 30—Gaseous Ammoniator—Paterson

An apparatus for the addition of ammonia gas, before or after chlorine, to potable water, to ensure its being tasteless, is shown in Fig. 30. It acts on the same general principles as the Chloronome.

W. H. Dorman and Co., Ltd.

There are four oil engines and two petrol engines on the stand of W. H. Dorman and Co., Ltd., Stafford. They range from 15 to 86 horse-power in the case of the oil sets and from 24 to 55 horse-power for petrol.

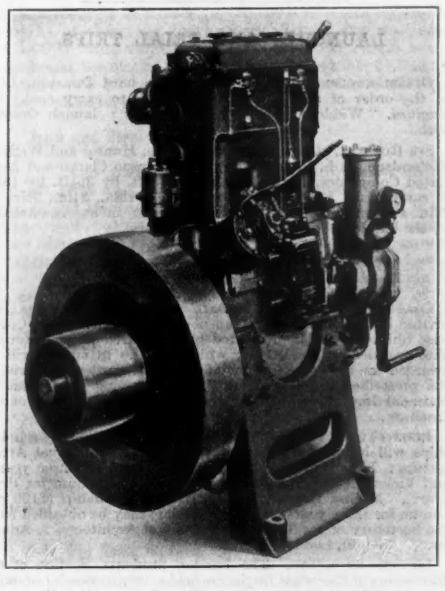


Fig. 31—15 H.P. Oil Engine—Dorman

We have chosen the smallest set for illustration in Fig. 31.

It is a two-cylinder engine of Ricardo type with cylinders 110 mm. in bore by 180 mm. stroke and it runs at 600 r.p.m. The cylinders are cast in pairs and have liners of nitrided cast iron. The cylinder heads are detachable and the whole assembly, head, block, and crank case, is held together by through bolts. The pistons are of aluminium alloy. The fuel pump is of Bosch make. The valves are overhead and are operated by rockers and a cam shaft in the crank case. The engine will run satisfactorily on paraffin, gas oil, solar oil, and any Diesel grade of fuel oil having a viscosity about 50 seconds Redwood at 100 deg. Fah. The power of the engine is obtained at or about sea level with fuels having a calorific value of about 19,500 B.Th.U. per pound gross. The fuel consumption at full load is 0·45 pint per B.H.P. hour on an average Diesel grade of oil.

The Consolidated Pneumatic Tool Company, Ltd.

All the plant and tools on the stand of the Consolidated Pneumatic Tool Company, Ltd., Egyptian House, 170, Piccadilly, London, W.1, is of the pneumatic type, and much of it is quite familiar. There are, however, some new features about the oil-engine-driven portable compressor exhibited. It is driven by a Dorman-Ricardo engine, and the compressor is fitted with the usual type of unloader, which comes into action when the receiver is fully charged with air. At the same time, the unloader acts on the engine governor to reduce the speed and save fuel as much as possible. The compressor has cylinders 5¾in. by 5in. and runs at 800 revolutions per minute. Its piston displacement is 120 cubic feet per minute, and the delivery pressure is 100 lb. per square inch. The engine has four cylinders, 4in. by 5in., and is designed to run on Diesel oil.

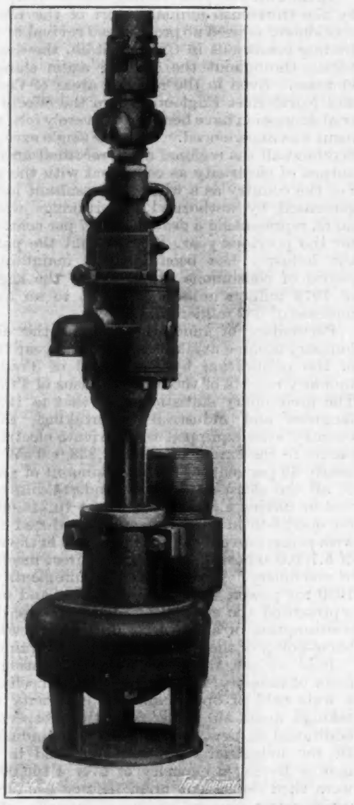


Fig. 32—Air Motor-Driven Sump Pump—Consolidated Pneumatic

The little sump pump illustrated by Fig. 32 has been brought out for such services as pumping surplus water from manholes, ditches, tanks, &c., and is driven by a rotary air motor. It is made in two sizes, one capable of pumping 145 gallons per minute against a head of 20ft., or 130 gallons against 30ft. The other set will raise 205 gallons per minute 20ft., or 175 gallons 30ft. The air pressure in each case is 90 lb. per square inch.

George Kent, Ltd.

Water-measuring and recording instruments of various kinds are exhibited by George Kent, Ltd., of Luton, and include the flow transmitter shown in Fig. 33, which is of the mercurial type, and is operated by the differential pressure produced by an orifice plate. In this transmitter a contact arm is rigidly attached to the gland spindle, which is operated by the float in the mercury chamber. The contact arm moves across a closely wound former immersed in oil. This coil or former is fed with an electrical supply through an iron resistance regulator, which maintains the current value constant. The voltage between the moving contact arm and one end of the coil is impressed on the receiving instrument, which is generally of the voltmeter pattern.

For the purposes of demonstrating the measurement of water flows, an installation has been arranged in which water is circulated by means of a pump. The water flows through a Venturi tube, over a weir plate, and through a flume. The flow through the 3in. Venturi tube is recorded on a mercurial recorder, which has a drum-type recorder 19in. long with a pen travel of 10in. The range of registration is approximately 1 to 14, and the accuracy within 1 per cent. at all normal rates of flow. The counter is constructed to give a ten-minute integration. After passing the Venturi tube the water is raised to a weir tank equipped with a V notch, and the head of water over the weir indicated by a dial indicator. Finally, the water runs down a Venturi flume at the rate of about 8000 gallons per hour. This flow is recorded by taking a pressure pipe from the upstream side of the flume to the float chamber. Above this float chamber and operated by the float there is mounted a recorder showing on a drum chart the rate of flow through the flume. This chart has a length of 11½in., a pen travel of 4in., and is equally spaced. The recorder has a range of registration of 1 to 30, and is fitted with a continuous integrator. There are also on this stand a number of instruments for recording at a distance flows, pressures, and levels.

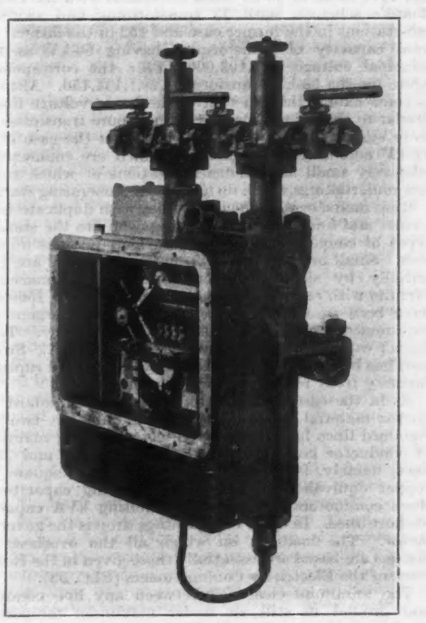


Fig. 33—Electrical Flow Transmitter—Kent

Blackstone and Co., Ltd.

There are a number of oil engines on the stand of Blackstone and Co., Ltd., Stamford, ranging in size from 10 to 60 horse-power in high-speed vertical sets, and up to 55 H.P. in horizontal form. They are of the compression-ignition type, and are fitted with the spring injection system with which our readers are familiar. In the case of the vertical engines the new C.C.C. system of pump injection for the fuel is used. In this each cylinder has its own pump, driven by a common cam shaft, and connected to the spray by a short pipe. The stroke of the pump is constant and regulation is effected by the governor by-passing some of the fuel. The arrangement is said to ensure a sharp opening and closing of the spray valve, so that there is no risk of dribbling at the beginning and end of the injection period.

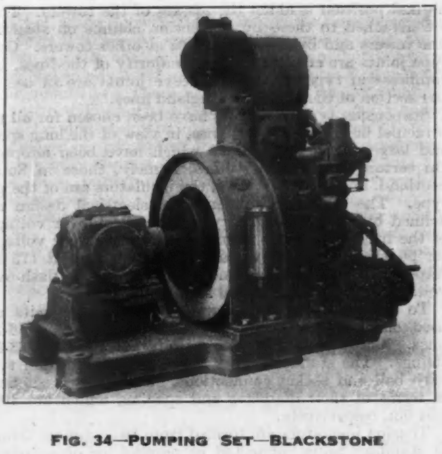


Fig. 34—Pumping Set—Blackstone

The 3in. pumping set shown in Fig. 34, which is driven by one of these engines, is shown running. The pump is of the Unchokeable type, which we have already described, but has a vertical spindle and is driven through the gear-box seen mounted on the bed-plate. The demonstration shows plainly how the pump can handle gravel and even small boulders without damage.

(To be continued.)

Grid Secondary Lines.

The lower-voltage sections of the British Grid System formed the subject of a paper read on Thursday, November 9th, by Mr. C. W. Marshall before the Institution of Electrical Engineers. Lines which operate at 66 and 33 kV are the principal sections of the grid considered, the few sections working at 22, 11, and 6·6 kV being relatively unimportant. There are 221 circuit miles of 66-kV lines and 1319 miles of 33-kV lines associated with the Central Board's schemes, with 33 transforming and switching sub-stations in the former case and 152 in the latter. The total capacity of transformers having 66-kV as their principal voltage is 1,193,000 kVA; the corresponding figure for the 33-kV transformers is 1,134,450. Although to some extent the function of the lower voltage lines is similar to that of the main grid lines, pure transmission is more closely approached, particularly in the case of the 33 kV and lower voltage lines, which are connected to relatively small and inefficient stations or which supply new undertakings which do not possess generating stations.

Ring mains or double-circuit lines with duplicate transformer and line supplies to each station are the standard types of connection wherever the load justifies duplication. Small or relatively unimportant supplies are given initially by single line and transformer connections. Circuits with capacities ranging from 40,000 to 1500 kVA have been provided to meet the widely divergent load requirements of different parts of the country. Transformer capacities range from 45,000 to 50 kVA. Switchgear has been used of practically every standard rupturing capacity from 1·5 million kVA downwards.

As in the case of the 132-kV lines, the standard conductor material is steel-cored aluminium, but two non-standard lines have copper conductors. Four main sizes of conductor have been used for the 66-kV and 33-kV lines, namely, 0·175, 0·15, 0·1, and 0·075 square inch copper equivalent. The current-carrying capacities of these conductors determine the limiting kVA capacities of short lines. In other cases voltage drop is the governing factor. The loadings on which all the overhead line designs are based are essentially those given in the Regulations of the Electricity Commissioners (El.C. 53).

The minimum clearance between any line conductor and ground in still air under maximum temperature conditions (50 deg. Cent.) is 20ft.; that for any earth conductor under the same conditions is 17ft. More stringent clearance or constructional conditions are imposed at certain classes of crossings. The normal span length for the various classes of lower voltage lines varies from 900ft. for 0·175 square inch steel-cored aluminium conductor lines to 400ft. for 0·1 square inch copper conductor lines. The maximum allowable span length on standard supports is 35 per cent. greater than the normal span for the line.

Standard angle supports are so designed that, when used with the maximum angles of deviation, the sum of two adjacent span lengths may, where ground contours permit, exceed by 10 per cent. twice the normal span lengths. The steel core is galvanised, and in cases where the conductor has only one layer of aluminium strands the core is coated with bitumastic compound before the aluminium wires are laid on.

After the lines have been put into service, resistance tests are made on each conductor, using currents of the order of full load. Thereafter control tests are carried out, at intervals of a year, on sections of conductors on lines in industrial areas where atmospheric pollution is abnormal and on others which are close to the sea coast.

Interlocked-strand steel-cored aluminium conductors have been used experimentally on a short section of 66-kV lines in North-East England. This type of conductor has the advantage of considerably reduced overall diameter and improved anti-corrosion properties.

Earth conductors are, except in a few specifically mentioned cases, of the same materials, and manufactured to the same specification as the line conductors. Their normal position is along the apexes of the towers. They are attached to these by suspension clamps on straight-line towers and by tension clamps at other towers. Cone type joints are employed in the majority of the lines, but compression type aluminium sleeve joints are in use on one section of the Mid-East England lines.

Suspension type insulators have been chosen for all the principal 66-kV and 33-kV lines, in view of the long spans and large conductor sections which have been adopted. On certain of the 33-kV lines, namely, those in South Scotland, and on 11-kV lines, the insulators are of the pin type. The basic requirements for electrical design are defined by the minimum dry and wet flash-over voltages of the insulators. The minimum dry flash-over voltages for 66-kV and 33-kV insulators are 280 kV and 175 kV respectively. The corresponding minimum wet flash-over voltages are 170 kV and 100 kV.

To meet these requirements, five insulator units are used on both suspension and tension strings on 66-kV lines. Correspondingly, three units are used on 33-kV strings. The standard units are of the cap-and-pin type with ball and socket connections. They may be defined in terms of their diameter and spacing, which are 10in. and 5in. respectively.

Tension insulators are formed from two or more strings of standard units connected in parallel, or of strings of special high-strength units, as may be required by mechanical considerations. Provision is made on the towers for fitting one additional standard insulator unit per string to provide against exceptionally onerous atmospheric conditions.

Arcing horns are fitted to the conductor clamp fittings of all suspension and tension insulator strings with the object of protecting insulators and conductors from the action of power arcs. So far, it has not been necessary to use special anti-fog or anti-dirt insulators on lower-voltage lines, but on certain lines immediately adjoining the sea coast the maximum number of standard insulators has been provided from the outset.

Lattice steel towers are standard for all the Board's 66-kV lines. They have also been used for all 33-kV lines, with one exception. In this case centrifugally cast concrete poles have been used as straight-line and medium-angle supports.

Standard towers are of the narrow-base type for small and medium-angle positions. The main members of these towers slope uniformly from base to top. Large-angle and terminal towers are of the broad-base type, with main members sloping uniformly from the base to the middle cross arm. The line conductor disposition is triangular on single-circuit towers and hexagonal on double-circuit towers, with the earth conductor at the apex.

Other sections of the paper cover foundations, earthing, tower tests, special constructions at crossings, underground cables, switching and transforming stations, and protective equipment. One of the most interesting statements made in connection with tapping the lines is that for the smallest connections transformers are teed off directly to the supply line through isolating and earthing switches, with or without protective fuses in the transformer primary circuit. Fuses have been introduced in these cases only when it is essential to disconnect the transformer locally in order to preserve continuity of supply on other circuits, for the Board's experience has shown that transformers may be directly connected to 33-kV lines without impairing reliability.

The Electricity Commissioners' Report.

Although the year ending March 31st, 1933, covered by the thirteenth annual report of the Electricity Commissioners, showed no pronounced revival in industrial and trading conditions in Great Britain, the demand for electricity throughout the country again showed a notable increase. Even in the regional areas of Central Scotland and North-East England, where the effects of the industrial depression have been most severely felt, some improvement was experienced. With the single exception of North Scotland all the regional areas recorded an increase in the output of electricity as compared with the previous year. For the country as a whole the resultant increase in units generated by authorised undertakings was 897 million units, representing a growth of 7·7 per cent. on the output for the previous year. Throughout the past three years the industry has been able to maintain an enviable record of continuous expansion to the aggregate extent of 1979 million units, equivalent to an average annual increase of 659 million units.

Particulars of much interest to the electric supply industry became available during the year 1932 as a result of the publication by the Board of Trade of the preliminary reports of the fourth Census of Production, 1930. The preliminary statistics show that in 1930 the various factories and industrial undertakings throughout the country were equipped with private electrical generating plants to the extent of about 2,833,000 kW (equivalent to nearly 40 per cent. of the total amount of generating plant in all the electricity supply undertakings), with electric motors having a capacity of about 10,244,000 horse-power for operation in part by factory produced electricity, and with prime movers having a capacity in the neighbourhood of 6,700,000 horse-power for the direct mechanical driving of machinery. The electrical requirements of industry in 1930 for power, inclusive of lighting and other purposes, represented the equivalent of an average demand for or consumption of about 1022 units of electricity for every horse-power of the total electric motor equipment installed.

It is evident, therefore, that the existing power equipment of industry, both electrical and mechanical, presents a wide field of opportunity to electricity supply undertakings, apart altogether from the prospects arising from additional or new uses of power for industrial purposes. Of the industrial equipment installed in 1930, electric motors having a capacity of over 4,100,000 horse-power were then dependent upon factory produced electricity, while prime movers having a capacity of the order of 6,700,000 horse-power were installed for direct mechanical drive. This equipment thus represents a potential addition of over 10,000,000 horse-power to the existing industrial load on the public supply systems as and when the factory generating plant and prime movers become obsolete.

Inclusive of the Central Electricity Board and allowing for the case of two companies with undertakings in England and also in Scotland, the number of separate undertakings at March 31st, 1933, was 650, a net decrease of ten on the number holding supply powers at the end of the preceding year. There were also four other statutory bodies not possessing powers to supply, but charged with definite duties of an advisory or supervisory character in respect of the organisation for the supply of electricity in districts within their jurisdiction.

The returns of units generated and fuel consumption, &c., rendered to the Commissioners in respect of generating stations of all authorised undertakers in Great Britain, including the voluntary returns in respect of all generating stations owned by railway and tramway authorities and of certain stations owned by non-statutory undertakings, are summarised in a table covering the year ended December 31st, 1932. The units generated showed a resultant increase of nearly 843 million, or 6·6 per cent., on the figures for 1931, the larger output being accomplished by an increase of 243,584 tons, or about 2·5 per cent. increase, in the amount of coal and coke consumed, and also by a small increase of 3575 tons in the amount of oil fuel used at generating stations as compared with the previous year.

The stations of authorised undertakers were responsible for an increased output of 831 million units, a growth of nearly 7·3 per cent. on the corresponding figure for 1931, public authority undertakers accounting for an increase of about 585 million units and company undertakers about 246 million units. The output from the stations of railway and tramway undertakings showed a falling off of over 9 million units, but in the case of the stations of the non-statutory undertakings included in the returns there was an increase in output of over 21 million units.

The progressive improvement in steam power station practice during the past three years alone is shown by the fact that the average number of units generated in the stations of authorised undertakers per ton of coal and coke consumed increased from 1200 units in 1930 to 1249 units in 1931 and to 1299 units in 1932.

A table showing the sales of electricity in Great Britain by authorised undertakers during the year ending December, 1932, together with comparative figures for previous years, indicates that during the last calendar year the units disposed of amounted to 10,096,966,827, an increase of 710·2 millions on the previous year. On the basis of the estimated population of Great Britain in 1932, namely, 45·08 million inhabitants, the sales of electricity from public sources of supply in that year represented an average consumption of approximately 224 units per head of population.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

TWO-COAT AND SINGLE-COAT ASPHALT (COLD PROCESS).

510 and 511—1933. These two specifications relate to asphalt road surfacing by the cold process. The drafts were prepared in the first instance by the Road Emulsion and Cold Bituminous Roads Association, Ltd., and were considered and approved with certain modifications, by the appropriate committee of the Institution, representing, in addition to the Ministry of Transport, the various interests concerned with the production and purchase of road materials.

Much careful research has been carried through with a view to perfecting asphalt processes, in which the use of heat is either greatly reduced or entirely eliminated. Both at home and abroad a very large area of roads has now been successfully surfaced by the various cold processes which have been evolved, and the specifications which have now been issued consolidate the experience of many years and widely varying conditions.

In hot asphalt the hardening of the mixture is, of course, dependent upon the cooling of the bitumen; for this reason the mixture must be spread and consolidated soon after manufacture. In the cold processes the hardening of the mixture is dependent upon other considerations, such as the evaporation of water, the evaporation of volatile oils, or the amalgamation of oil and bitumen. By making use of these features, those responsible for the development of the cold processes have introduced materials which not only require the minimum of heat (if any) during their manufacture, but which may be so controlled that the spreading and consolidation may be carried out when desired with the mixture in a cold state. The transport of the mixture by road or rail for long distances becomes possible, and its storage for use when needed is a practicable proposition.

Owing to the fact that in the so-called cold processes little or no heat is used, relatively inexpensive plants may be employed; excellent work, for instance, can be done with the ordinary concrete mixer, which is already in the possession of most highway authorities and contractors.

The arrangement of the specifications follows the lines of previous road surfacing specifications issued by the British Standards Institution, the first part being devoted to definitions, the second to materials, and the third to construction and workmanship. In a series of appendices are described tests demanded by the specifications. Owing to the variety of processes covered by these specifications the limits laid down are necessarily wide. The intention is that, when inviting tenders, engineers should state the classification and table of these specifications with which tenders should comply, and that the contractors should specify in their tenders the actual gradings and percentages of ingredients of the materials they offer. If this procedure is adopted, tenders will be submitted on a comparable basis and their consideration will be greatly simplified.

LAUNCHES AND TRIAL TRIPS.

Diesel-engined Barge; built by Richard Dunston, Ltd., to the order of the Leeds Corporation; to carry coal. Oil Engines, "Widdop" twin-cylinder 50 H.P.; launch October 20th.

Sir Russell, steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Stephenson Clarke and Associated Companies, Ltd.; dimensions, 252ft. by 36½ft. by 18ft.; to carry coal. Engines, triple-expansion, 19in., 31in., 51in. by 26in. stroke, pressure 180 lb. per square inch; constructed by the builders; trial trip, November 10th.

Coastwise Shipping Medal, 1934.—Contributions are invited by the Institute of Transport in competition for a Coastwise Shipping Medal, presented by Sir Alfred Read, a former Vice-president. The Medal, which will be in silver, will be awarded for the contribution judged first in order of merit on the prescribed subject, "The British Coasting Trade and its National Importance." The writer must be a member of the Institute.

Institution of Naval Architects.—The following scholarships will be offered for competition in 1934:—Naval Architecture: Elgar Scholarship (£130 per annum for three years), and Vickers-Armstrong Scholarship (£150 per annum for three years). Marine Engineering: Yarrow Scholarship (£100 per annum for three years). Full particulars may be obtained from the Secretary of the Institution of Naval Architects, 2, Adam-street, Adelphi, London, W.C.2.

London Students.—The London Students' Section of the Institution of Electrical Engineers held a very successful smoking concert at Carr's Restaurant on Thursday evening, November 9th. Well over 100 members of the section attended, and among the guests were Mr. P. V. Hunter, President of the Institution; Mr. H. T. Young; Mr. J. H. Heynor, editor of the *Students' Journal*; and student and graduate representatives of the Institutions of Civil and Mechanical engineers.

Williams Prize.—The Williams Prize of the Iron and Steel Institute has this year been awarded by the Council jointly to Mr. D. F. Marshall, of Sheffield, for his paper on "The External Heat Loss of a Blast-furnace," which was presented at the last annual meeting of the Institute in London, and to Mr. A. Robinson, of Scunthorpe, for his paper on "Some Factors Leading to Greater Production from a Steel Furnace," which was presented at the autumn meeting of the Institute held in Sheffield in September last.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Satisfactory Import and Export Figures.

The improvement in the iron and steel trades is reflected in the figures of imports and exports provided by the Board of Trade returns for October. Both imports and exports are up, the total imports for October being 88,854 tons, compared with 80,342 tons in September, whilst the exports total 193,613 tons for October, against 157,367 tons for the previous month. The imports of Continental pig iron are insignificant, but 1679 tons was sent to this country from Sweden. This, of course, relates to special iron. Of the remaining 4486 tons of forge and foundry iron, 2287 tons came from British India. No Continental basic iron was imported in October, and the 3000 tons which came in was Indian iron. It is scarcely surprising, perhaps, in view of the increased demand and the rise in prices in this country, that the imports of semis show an increase over the past three months. In August 20,085 tons of blooms, billets and slabs were imported, and this rose to 24,871 tons in September and to 28,511 tons in October. This, however, is less than half the quantity imported over the corresponding months in 1931 under Free Trade. The increase in the imports of sheet bars has not been so noticeable. Last August 4168 tons came into the country; in September this had risen to 8980 tons, and in October receded to 8626 tons. The imports of girders, beams, and joists show a decline on the past three months from 6015 tons in August to 5933 tons in September, and 4487 tons in October. Compared with the ten months of last year, however, imports are slightly up, being 63,423 tons for this year, 60,790 tons for 1932, and 86,512 tons for 1931. The imports of hoop and strip have increased to 9934 tons for last month, compared with 8668 tons in September. So far as exports are concerned, the figures for pig iron show a decline to 7559 tons, compared with 8138 tons in September. Exports of plates and sheets, not galvanised, last month totalled 8875 tons, an increase of over 2000 tons compared with September. There was also an increase of nearly 1000 tons in the exports of plates and sheets under ⅛in. thick. The exports of galvanised sheets, probably as a result of the Argentine order, jumped from 22,028 tons in September to 41,151 tons in October, whilst the exports of tin-plates were 3000 tons up last month at 34,040 tons. The total quantity of railway material exported also improved during October to 9161 tons, compared with 8386 tons in September.

Machinery Exports.

The exports of machinery during October remained fairly steady so far as tonnage was concerned; but the value was £203,166 higher than in September, being £2,509,603, compared with £2,306,437 in October. Exports of textile machinery in October were valued at £475,670, compared with £385,077 in September. Of this total British India took machinery valued at £153,765, the next largest individual customer being China with £41,870. The exports of prime movers increased in value during October to £266,577, compared with £216,199 in the previous month. Here, again, India took machinery valued at £38,780, whilst the Soviet took £19,243, and British South Africa £17,850. The exports of agricultural machinery, however, were down, the value of the October total being £40,030, compared with £50,787 in September. The value of machine tools for metal working exported during October amounted to £74,625, but for the ten months ending October 31st the value was £1,109,003, less than half the 1932 total for the similar period of £2,674,959. It is interesting to note that during the ten months of this year the exports include one war vessel of 14,026 tons, valued at £225,000, whilst steam vessels numbered seven, of 31,412 tons, valued at £1,579,589. Seventy-two motor vessels were exported of 2427 tons, valued at £114,020.

Iron and Steel Production.

The monthly statement of the National Federation of Iron and Steel Manufacturers upon the production of pig iron and steel shows that the situation is still sound, and that the production of pig iron was the highest since November, 1930. There was no change in the number of furnaces which remained at seventy-four, two having been blown in and two having ceased operations during the month. Although the report does not mention it, of the furnaces blown in, one was at the Carron Company's works and one at the New Cransley Iron and Steel Company, in Northamptonshire. Of those which ceased production, one was at Goldendale, Staffs., and one at Renishaw. The production of pig iron in October amounted to 373,300 tons, compared with 359,700 tons in September and 275,600 tons in October, 1932. The production includes 102,400 tons of hematite, 175,400 tons of basic, 78,500 tons of foundry, and 8500 tons of forge pig iron. The output of steel ingots and castings in October amounted to 668,300 tons, compared with 669,000 tons in September, and 439,800 tons in October, 1932.

The Pig Iron Market.

The most interesting feature of the advance in the price of basic pig iron which was announced recently is the system of rebates which has been introduced. Hitherto official rebates in this department of the industry have been calculated over lengthy periods, but the producers now offer monthly rebates, a concession which consumers are likely to appreciate. To obtain the rebates consumers have to give a certificate that they have not purchased any foreign iron. The rebates are available to consumers of Indian basic iron as well as to users of the home product. The inclusion of the Indian producers in the scheme could not be avoided, since the Tata Iron and Steel Company, Ltd., the only maker of Indian basic pig iron, is closely associated with the British makers, and is a party to an agreement by which the company has an allotment of 60,000 tons for sale in the British market, and under which it observes the British producers' scale of prices. These vary according to the makers' system of zones; but the advance has been general and amounts to 7s. 6d. per ton, the rebate under the conditions mentioned being 5s. per ton. As practically no foreign basic pig iron is being imported, the net increase to consumers will be 2s. 6d. per ton. The advance has been well timed, as the demand is strong on the increased activity in the steel trade. An indication of this is given by the decision of Dorman, Long and Co., Ltd., to re-light a furnace at their Cleveland works, and another at their Acklam plant. Both these furnaces will produce basic iron for their steel works, and it is expected that the whole of the additional output will be absorbed by the firm's steel works. In other districts, also, the consumption of basic iron is on a good scale. In the foundry iron section of the market large orders are rather scarce, as so many users, particularly the important ones, have covered themselves well forward. Deliveries against contracts, however, are on a satisfactory scale. The demand for hematite has increased considerably of late, and business with Yorkshire consumers has been transacted for delivery over the first quarter of next year.

Semi-finished Steel.

The chief characteristics of the market are the strength of the producers' position and the steadily increasing tightness of supplies for near delivery. Although the official rate for British billets of ordinary rolling quality was recently fixed at £5 5s., it is by no means easy to place orders at this figure. The majority of the makers ask £5 7s. 6d., but there are some who stand out for £5 12s. 6d. Continental producers have taken advantage of the opportunity afforded them by the stringency of the position and the higher British prices to advance their quotations. Officially, the increase is said to be 2s. 6d. gold, but actually the full advance does not seem to be insisted upon. An interesting change, however, appears to have been made in the Continental quotations, and the prices quoted in the Birmingham area are now higher than for other districts in Great Britain, which is contrary to the position which ruled until recently. The alteration is probably due to the demand for foreign billets being principally from the Midlands. The demand is principally for 2in. and 2¼in. billets, which are now quoted at £5 10s. d/d for the Midlands and £5 5s. elsewhere. For 2½in. and up the price is £5 8s. d/d Birmingham area. In the case of customers of old standing, or when attractive tonnages are involved, prices are subject to special negotiation. The demand for sheet bars is improving, but is less consistent than for billets. British sheet bars are quoted at £5 5s., and in some cases up to £5 7s. 6d. Continental sellers are asking £5 d/d. An example of the effect of the advance in the price of billets is provided by the increase in the re-rollers' price for strip, which is now £9, the quotation for Continental material ranging from £7 6s. 6d. to £8. The Continental makers, therefore, by raising the price for billets, have forced the strip makers to raise their prices, and, at the same time, have kept their own strip quotations low. The strong demand for semis is said to be the chief cause of Dorman, Long and Co. putting into blast two steel furnaces at their Britannia works.

Finished Materials.

Apart from the rather brighter prospects in the shipbuilding industry, business in the finished steel department is on a sounder basis than at any time this year. The recent expansion in business may not have been so extensive as was forecast for the autumn, but there has been much less irregularity in the demand from the home trade, and the steel works are maintaining a steady rate of operations. Lately export trade in finished steel has shown signs of increasing principally with Empire markets, whilst the home demand has certainly not relaxed, and according to some reports has actually improved during the past fortnight. On the North-East Coast the position is sufficiently encouraging to warrant hopes of more plant being put into operation. The structural engineering side of the business in this district is well employed. The rail departments are fairly busy and recent orders for chairs and fish-plates have been secured from the South African Government. The ship repairing yards are also taking fair quantities of steel. In the Midlands the recent rate of output has been maintained. Although it is said that the constructional engineering industry has not become so active as appeared likely early in the month, it is taking fairly regular supplies. The demand is principally for the lighter classes of steel, and business in strip, small bars, and, to a lesser degree sheets, is expanding. The re-rollers hold their price of £7 for re-rolled small bars excepting when they are competing for a good line with Continental works, who continue to quote £6 9s. 6d. to £6 10s. including duty. The steel works are also well employed on this class of material and quote £7 5s. to £8 5s., the wide variation in the quotation being due principally to the difference in the state of some of the works' order books. Competition from the Continent in the Midlands, however, is not serious, and although angles are quoted at £6 15s. to £6 17s. 6d.; joists, B.S., at £6 17s. 6d. to £6 18s.; and plates, $\frac{3}{16}$in. and up, at £8, the amount of business going abroad is not large.

Scotland, Lancashire, and the North.

Steady conditions continue to rule in the Scottish steel markets, and although the demand for shipbuilding material cannot be considered satisfactory, the prospects of an improvement in this direction have promoted a cheerful tone. The structural engineers in Scotland are not busy, but, nevertheless, a fair volume of steel is finding an outlet through their works. Conditions in the tube industry, however, have improved, and the demand for hot-rolled and solid-drawn tubes is on a good scale. The recent improvement in the demand for sheets has been maintained, and although this is largely confined to the heavy gauges, it has been sufficient to keep most of the tube works well employed. The Canadian open water season is now over, and on the whole has been rather disappointing so far as the exports of Canadian steel are concerned. Re-rollers in Scotland are not experiencing busy conditions, and in most cases are at work only half the week. They have retained their price, however, at £7 5s. d/d Glasgow and £6 15s. for export. Conditions in the Lancashire steel market have improved considerably of late, and one of the most satisfactory features is the expanding demand from the structural engineers. An increased disposition on the part of users to buy forward is the result, probably, of the tendency of prices of uncontrolled steel material to advance. For some time past business in special and alloy steels has been satisfactory. The demand also for small bars and hoops has been increasing and in some cases the delivery times have been extended. The re-rollers in this district continue to quote £7 10s. for small bars, but makers in other districts have taken business in Lancashire at lower figures. One of the disappointing features of the market is the failure of the demand for boiler tubes to increase. Business in this department has been at a low ebb for some time, but recently there were indications which have not been fulfilled that the corner had been turned. Activity continues to rule in the Yorkshire steel trades, particularly in the Sheffield district. Business in alloy and tool steel has been on a particularly good scale. There has also been a good demand for rods for reinforced concrete work. Rather irregular conditions exist at some of the Yorkshire structural engineering shops, but the volume of business arising from the requirements of this section of the industry is not decreasing.

The Copper Market.

In spite of the disturbance to trade created by the American policy of depreciating the dollar, or because of it, good business has been done in electrolytic copper. Most of the consuming markets have bought with freedom, and the producers have been equally ready sellers as the market declined. This is a reversal of the policy they have pursued for some years of trying to maintain the market by limiting their sales when prices fell. In fact, in some quarters the view is held that the unsatisfactory situation which has grown up in the copper market since the war is largely due to the mistaken policy of the copper producers in endeavouring to obtain complete control of the market and to eliminate merchants. In this case also they appear to have changed their tactics, and are now willing sellers to merchant interests. The latter have bought considerable quantities at the recently ruling prices. Another reason, of course, for the American producers' eagerness to affect sales is that they can sell in sterling at a low figure and still make a comparatively good return in American currency. As the exchange value of the dollar declined, the price dropped from £35 5s. to £34 10s. c.i.f. No doubt much of the buying in the United States has resulted from the new tendency in that country to invest in commodities as a hedge against further currency depreciation. However, the producers' quotation as a result of the improved sales, advanced to 8.25 c. d/d, and, according to reports, further increases are expected. The failure of the big copper producers and the Customs smelters to reach an agreement regarding the "code" has not greatly influenced the market, since the whole situation for the time being seems to turn upon the American monetary policy. In Europe there is little confidence in the position, but consumers have taken advantage of the cheap prices and have bought fair quantities. There has also been a certain amount of investment buying from countries still on the gold standard. The London standard market has been much under the influence of conditions in the electrolytic department. Prices have slipped back, although the movements have not been important. Comparatively little speculative interest has been shown in this metal, and the easier tone has resulted in some bulls getting rid of their commitments Nervous markets developed in mid-week owing to the depreciation of the dollar exchange. The electrolytic price dropped £1 to £1 10s. and standard, cash and forward, were £1 16s. 3d. to £1 17s. 6d. lower.

Tin.

A rather brighter tone developed in this market on the renewal of American purchases, which were ascribed by the market to the desire of American buyers to exchange their dollars for commodities. At the same time, it is probable that some of the new buying has been for industrial purposes in the belief that values in this market are more likely to advance than to recede. The sharp break in the dollar price last week, followed by expectations of movements such as those described, were responsible in part for a firmer tone, so that when the buying actually matured the price movements were comparatively narrow. A feature of the market at the moment is the scarcity of prompt metal, which has resulted in a backwardation of £1 to £1 2s. 6d. The stocks of tin in this country are only a little over 11,000 tons, and if buying by the United States develops on a serious scale they may be again materially reduced. This possibility has created some nervousness in the market, although the approach of the New Year, when there will be an increase in exports, has naturally had a steadying influence. The demand from consumers on the Continent has been poor, although there have been some transactions with Italy. Disappointment, however, is felt at the slowness of the Continental markets to develop. The continued fall in the dollar exchange in mid-week resulted in realisations, and prices dropped sharply, £2 10s. for cash and £3 for forward.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ¼in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ⅜in.	9 10 0	8 5 0
„ 7/16in.	9 15 0	8 10 0
„ ½in.	9 7 6	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ¼in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 10 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 15 0
Plates, ¼in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 7 6	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ¼in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ⅜in.	9 10 0	9 12 6
„ 7/16in.	9 15 0	9 17 6
„ ½in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 17/–.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 2 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 2 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, November 15th.

Copper—		
Cash	£29 7 6 to £29 8 9	
Three months	£29 11 3 to £29 12 6	
Electrolytic	£33 0 0 to £34 0 0	
Best Selected Ingots, d/d Birmingham	£33 10 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£32 0 0 to £34 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£226 15 0 to £227 0 0	
Three months	£226 5 0 to £226 10 0	
Lead:	£11 0 0 to £11 5 0	
Spelter:	£14 10 0 to £14 17 6	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 14/3
„ Glasgow— Ell	12/6 to 14/3
„ „ Splint	15/6 to 15/9
Ayrshire—	
(f.o.b. Ports)—Steam	12/– to 12/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/6 to 14/–
Unscreened Navigation	12/3 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/– to 13/6
Secondary Steam	13/–

ENGLAND.

	Inland.	
Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/6 to 20/6
Furnace Coke		13/– to 17/6
Northumberland—		
Blyth Best		13/9 to 14/–
„ Second		12/9 to 13/–
„ Best Small		11/–
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/6
Foundry Coke		17/– to 18/6
Sheffield—	Inland.	
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	6/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	17/9 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	19/– to 36/–
Furnace Coke	16/– to 17/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	10/– to 11/–
Steam Coals:	
Large	18/– to 20/6
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Rail and Road Controversy.

Before any final plan of combined road and rail traffic organisation can be adopted the fullest data have to be collected concerning the changed conditions of transport and the requirements of railway companies, road haulers and users, and such data are being abundantly provided by reports and statistics collected by the Office Central du Rail et de la Route. The problem is not quite the same as in Great Britain, for geographical conditions in this country, with long distances and a vast network of roads through relatively thinly populated regions, are perhaps more equally favourable to both methods of transport. Nevertheless, long-distance transport is no longer a monopoly of the railways, which have to compete with road haulage even between Paris and Marseilles. The difficulty of conciliating the interests of both methods of traction lies in the fact that the lorry has not yet given the full measure of what it can do in dealing with different classes of goods, for its progress has been rapid, and what it is doing to-day may be largely surpassed in the early future. The railway companies, on the other hand, are making equally rapid progress in adapting themselves to the new condition of things by improving rolling stock, accelerating services, collecting and delivering goods from door to door, and offering every facility to those on holiday or pleasure bent. During this period of progressive rivalry in providing the public with what it needs, and at the same time creating new needs, there can be no question of an amicable collaboration between the railway companies and road haulers. Those engaged in road transport are powerfully organised in a national federation, and refuse to enter into any combination which may place them under the domination of the railway companies. What appeared to be an acceptable arrangement was come to provisionally about a year ago, but the Federation declared that it had nothing to do with the matter, and the agreement was dropped. It is probable that the railway companies would never have had their existence threatened if it were not for the special tax of 32·5 per cent. which the State imposed on passenger fares in 1926. That tax has now been reduced to the previous figure of 12 per cent. One effect of the tax was a considerable diminution in the number of passengers carried. For eight first-class passengers carried in 1913 there is only one in 1933, and that one is almost certainly travelling with a free pass; and for thirty-eight second-class passengers in 1913 there are now only seven. The companies are organising a door-to-door service for perishable commodities at reduced rates, and by so doing they have recovered some of the traffic that was carried by road, though in some cases at the cost of smaller receipts. The case for road haulers is that the lorry has improved transport facilities in districts away from the railways, and has helped to bring prosperity to them, and Monsieur Mariage, managing director of the company which monopolises public passenger transport in Paris and the Department of the Seine, declares that the solution of the problem lies in running services at the highest speed consistent with safety, for which reason the construction of special motor roads is included in the national programme of public works. Meanwhile, the policy of the State is to put a curb upon weights and speeds on the road, and lorry owners are agitating strongly against what they claim to be an attempt to strangle their industry. The requirements of agriculturists and other producers have also been canvassed. Their preference is for the most convenient and economical form of transport, and they refuse to be burdened with extra charges that may follow upon an organisation that aims at conciliating the interests of railway companies and road haulers. It is probable that the State will eventually carry through a plan something on the lines of that proposed by the Compagnie du Nord for creating central railway collecting and distributing centres with the aid of lorries and with the collaboration of private lorry owners.

Public Works.

The importance of carrying out public works for the general well-being of the population influenced the discussions of the International Health Congress which was held in Paris recently. Rural water supply, drainage, electrical and gas distribution would, it was said, provide considerable employment, remunerate capital, improve national health, and increase land and property values. So far as rural electrification is concerned, it has always been argued that a supply of electricity for lighting and power purposes would change completely the conditions of existence in country districts and check the depopulation which threatens the agricultural industry, and at a time when the decline of activity in manufacturing industries is accompanied by the return of quite a large percentage of operatives to the country, where they can always find work, the electrification scheme is undoubtedly rendering good service. Whether the scheme is profitable to all suppliers of electricity is another matter, for rural consumers complain of the cost of current and use it parsimoniously, and the idea of electricity being employed generally for agricultural purposes has so far failed of realisation. The supplying of communes with water is particularly urgent in view of the conditions under which rural populations often live, with water drawn from possibly contaminated sources, while in some areas droughts are almost of normal occurrence. For many years the State has offered financial aid and technical assistance in the carrying out of plans for supplying water to communes, but only 10,657 communes out of a total of 38,000 are provided with such a supply, and the State is at present unable to continue the money grants it has been making to them. The International Health Congress therefore proposed that in the scheme of public works preference should be given to a plan of water distribution by mains from central sources of supply in such a way as to ensure that all the communes throughout the country shall be provided with good water. There is so general an insistence on the programme of public works being put in hand without delay that the Government will have no alternative but to provide the means of financing it. In present circumstances this can only be done by means of a public loan.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

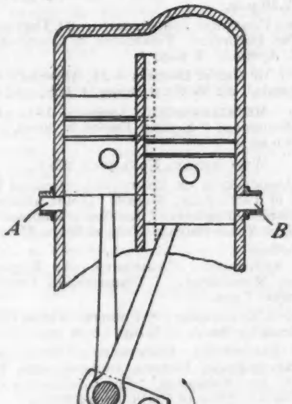
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

399,039. November 23rd, 1932.—Two-stroke Engines, M. Y. A. Serruys, 2, Rue Leregrattier, Paris, France.

This is a two-stroke internal combustion engine operating on a cycle in which, even at full load, the mass of fresh gases supplied is not higher than 0·6 of the mass corresponding to the theoretical volume of the cylinders and only part of the burnt gases is exhausted, the remainder of the latter in the cylinder being compressed again with a volumetric compression ratio which is higher than 60 per cent. over the volumetric compression ratio of a usual two-stroke engine, a feeding pump or compressor driven by the engine being provided and so arranged that it is prevented from supplying, even at full load, and at each revolution, a mass of fresh gases higher than the above indicated proportion. The common combustion chamber is shaped as to take advantage of the phase displacement between the pistons at the end of the compression stroke whereby an energetic mixing of the gases is effected at or near the end of the compression.—*September 28th*, 1933.

N°399,039

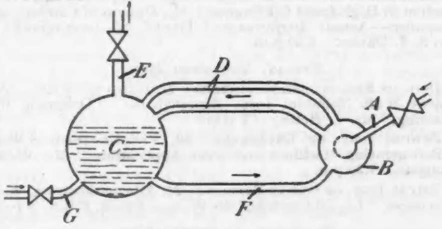


STEAM GENERATORS.

399,308. September 9th, 1932.—Steam Generators and Desuperheaters, *Babcock and Wilcox, Ltd., Babcock House, Farringdon-street, London, E.C.4.*

The raising of superheated steam to temperatures as high as possible involves, say the inventors, the necessity of again partly or wholly withdrawing from this superheated steam its superheat. Where, for example, the superheating is only to be reduced, this is usually possible by cooling a part of the superheated steam and mixing it with the remaining uncooled steam. Sometimes it is desired to desuperheat a large quantity of superheated steam and to obtain very dry saturated steam. Steam is consequently desuperheated by mixing the superheated steam in a mixing vessel or chamber with a liquid of boiling temperature and leading the mixture through connecting pipes into a separating chamber, from which the saturated steam formed may be withdrawn while the liquid is returned in circulation to the mixing vessel or chamber.) The superheated steam is led by the pipe A into a mixing chamber B. The superheated steam is distributed uniformly over the whole length of the mixing chamber. The steam separating chamber C is connected with the mixing chamber, such steam separating chamber being assumed in the present instance to be a boiler drum. The separating chamber C is only partly filled with liquid and is disposed at such a level that with the normal filling the chamber B is wholly or almost wholly filled with liquid. The two drums are connected by groups of tubes. If superheated steam is introduced through the tube A such steam will mix with the water and force a steam and water mixture into the tubes D, which mixture flows in the direction of the arrows and discharges as steam and water into the drum C. The saturated steam thus formed is withdrawn by the pipe E from the drum and flows to a superheater or consuming device. It may also be mixed with the part of the superheated steam not passed through the cooler. The separated liquid is mixed with the contents of the drum C and flows through the tubes F in circulation back to the mixing chamber B. The water evaporated can be replaced by a feed pipe G.—*October 5th*, 1933.

N°399,308

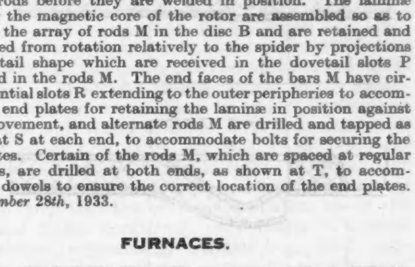


DYNAMOS AND MOTORS.

398,984. July 19th, 1932.—Dynamo-electric Machines, Gustaf Adolf Juhlin, of "Redscar," Moss-lane, Timperley, Cheshire, Thomas Hadwen Charlton, of 82, Church-road, Urmston, Lancaster, and Associated Electrical Industries, Ltd., of Crown House, Aldwych, Westminster.

An improved form of spider for supporting the rotor laminations of electrical machines is described in this specification. The disc member is formed from a plate of mild steel, and may conveniently be cut to its circular formation by means of a cutting flame. Equally spaced recesses A are cut out from the periphery of the disc B. Small holes C and larger holes D are drilled in the disc to reduce its weight. The disc is mounted on a hub member E constructed of rolled steel tube, and is connected thereto by welds F and G, whilst the hub member is secured to the rotor shaft by a key which is accommodated in a keyway H. Fillets J and K of black steel bar, rolled to the desired diameter, are fitted in the angles between the hub E and the disc B, and are welded to these two parts. In order to stiffen up the disc laterally ribs L are provided on each face of the disc B. They are assembled radially to extend between the innermost portions of the cut-out recesses A, to the outer peripheral surfaces of the fillets J and K, and are welded to these fillets and to the disc B. The rods M, which are of black steel bar, are accommodated in the recesses A, and are welded to the disc B at N, and to the ribs L, and also to the outermost parts of the ribs. The outer segments of the rods, as denoted by the dotted portion O, are removed, after the assembly has been welded and dovetail grooves P are cut longitudinally in the rods, longitudinal slots, denoted by dotted lines Q, being cut in the rods before they are welded in position. The laminæ forming the magnetic core of the rotor are assembled so as to encircle the array of rods M in the disc B and are retained and prevented from rotation relatively to the spider by projections of dovetail shape which are received in the dovetail slots P provided in the rods M. The end faces of the bars M have circumferential slots R extending to the outer peripheries to accommodate end plates for retaining the laminæ in position against axial movement, and alternate rods M are drilled and tapped as shown at S at each end, to accommodate bolts for securing the end plates. Certain of the rods M, which are spaced at regular intervals, are drilled at both ends, as shown at T, to accommodate dowels to ensure the correct location of the end plates.—*September 28th*, 1933.

N°398,984

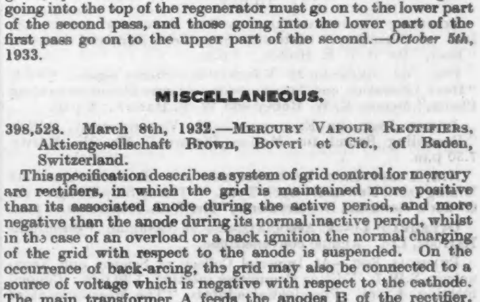


FURNACES.

399,409. March 23rd, 1933.—Regenerators, *H. A. Gill*, 51, *Chancery-lane, London, W.C.2.*

The inventors explain that with the usual arrangement of regenerator there is a tendency for the hot gases, whose heat is to be utilised, to rise into the upper part of the regenerator, while the cold air, which is to be heated, tends to flow through the lower parts. As a consequence they definitely guide the gases, by the baffle A, or some such means, so that the hot gases going into the top of the regenerator must go on to the lower part of the second pass, and those going into the lower part of the first pass go on to the upper part of the second.—*October 5th*, 1933.

N°399,409



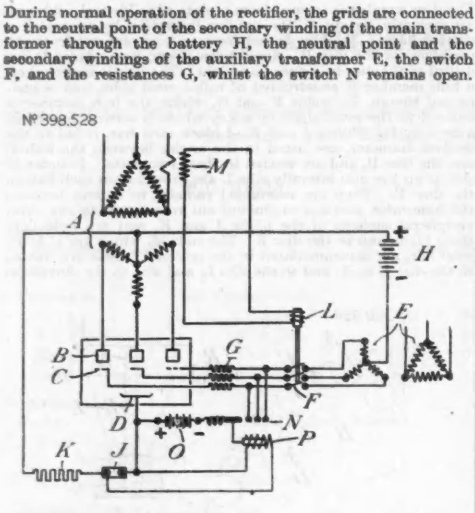
MISCELLANEOUS.

398,528. March 8th, 1932.—Mercury Vapour Rectifiers, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

This specification describes a system of grid control for mercury arc rectifiers, in which the grid is maintained more positive than its associated anode during the active period, and more negative than the anode during its normal inactive period, whilst in the case of an overload or a back ignition the normal charging of the grid with respect to the anode is suspended. On the occurrence of back-arcing, the grid may also be connected to a source of voltage which is negative with respect to the cathode. The main transformer A feeds the anodes B of the rectifier. Grids C are interposed between the anodes and the cathode D, and are fed during normal operation by the auxiliary transformer E through a switch F and resistances G. The neutral point of the secondary of this transformer is connected as shown to the neutral point of the secondary of the main transformer through a battery H. The cathode D is connected through the shunt J and the load K to the neutral point of the secondary of the main transformer. The switch F is closed during normal operation of the rectifier and is arranged to break the connection of the grids to the transformer E when necessary by means of the solenoid L, which is energised by the current transformer M, associated with the primary of the main transformer A. The leads between the grids C and the switch F are connected by way of a switch N and a battery O to the cathode. The switch N is normally open, but may be closed by the solenoid P when the latter is energised by a predetermined current through the shunt J.

During normal operation of the rectifier, the grids are connected to the neutral point of the secondary winding of the main transformer through the battery H, the neutral point and the secondary windings of the auxiliary transformer E, the switch F, and the resistances G, whilst the switch N remains open.

Nº 398.528



When a back-fire occurs the solenoid operates and opens the switch F and isolates the grids from the transformer E. The back-fire may also cause the solenoid P to close the switch N and impose a voltage upon the grids which is negative with respect to the cathode D by the voltage of the battery O.—*September 8th*, 1933.

398,771. April 29th, 1933.—COMPOSITE GASKETS, C. Kaiser, Schillerstrasse 47, Heilbronn am Neckar, Germany.

In order to key together the several thicknesses of a composite gasket, such as one made of asbestos and copper sheets, the pack is subjected to a pressing operation, as shown in the drawings. A punch first makes a dent in the top sheet, which is consequently stretched. Further descent of the punch sheers off first the top sheet, and then the bottom sheet, but on one side only. The pack is then flattened out again in another press, so that the elongated end of the stretched dent is tucked into the asbestos. The process is repeated on the opposite side. —*September 21st*, 1933.

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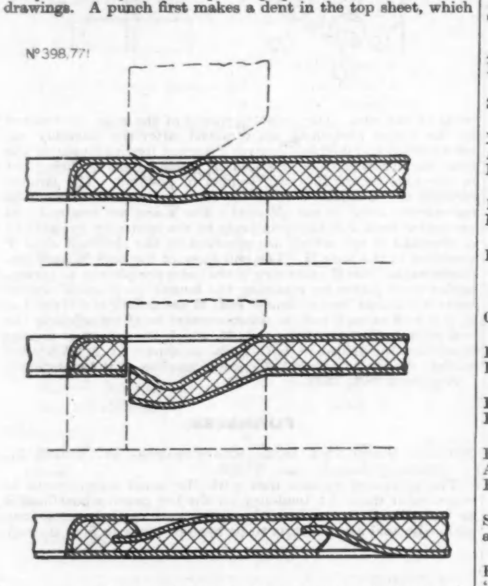

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOC.—At Inst. of Chemistry. Sixteenth Streatfield Memorial Lecture, "Beer," Mr. H. F. E. Hulton. 8 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Heat Liberation and Transmission in Large Steam-generating Plants," Messrs. E. W. Robey and W. F. Harlow. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Recording Sound for Motion Pictures," Mr. W. Harris. 7.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "Tramp Ship Design: An Owner's Views and Requirements," Mr. W. L. Runciman. 6 p.m.

OVERHEAD LINES ASSOCIATION.—At Georgian Restaurant, Harrods, Ltd. Annual conversazione.

PHYSICAL SOC.—At Imperial College of Science and Technology, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m. Presidential address, "The Measurement of Magnetic Field Distortion," Professor A. O. Rankine. 5 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Sir Herbert Baker. 9 p.m.

WEST OF SCOTLAND IRON AND STEEL INST.—At Royal Technical College, Glasgow. Council meeting, 6.45 p.m. "Fusion Welding of High-pressure Vessels Combined with X-ray Examination," Mr. R. Rankine Lynn. 7.15 p.m.

TO-DAY AND SATURDAY, NOVEMBER 18TH.

PUBLIC WORKS CONGRESS AND EXHIBITION.—Royal Agricultural Hall, Islington, N.1. Daily. (For programme see page 365).

SATURDAY, NOVEMBER 18TH.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to works of P. Garnett and Sons, Ltd., papermakers, Otley. 3 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "The Course and Causes of the World Depression," Mr. L. C. Robbins. 3 p.m.

MONDAY, NOVEMBER 20TH.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND.—At James Watt Memorial Inst., Birmingham. "The Lower Voltage Sections of the British Grid System," Mr. C. W. Marshall. 7 p.m.

INST. OF ELECTRICAL ENGINEERS: WESTERN CENTRE.—At Cheltenham. Discussion on "Gale and Storm Damage." Opener, Mr. W. D. Tuck.

INST. OF MECHANICAL ENGINEERS: GRADUATES.—Storey's-gate, S.W.1. "Oil-fired Furnaces," Mr. R. H. B. Forster. 6.45 p.m

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. Cantor Lecture, "Colour Block Prints," Lecture I., Mr. Hesketh Hubbard. 8 p.m.

TUESDAY, NOVEMBER 21ST.

INST. OF AUTOMOBILE ENGINEERS.—At Victoria Hotel, Wolverhampton. "The Correlation of Metallurgical and Economic Problems in the Selection of Automobile Engineering Materials," Mr. L. B. Hunt. 7.30 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Impact of Wheels on Roads," Messrs. F. Aughtie, R. G. C. Batson, and A. F. C. Brown. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND STUDENTS.—James Watt Memorial Inst., Birmingham. "An Electric Totalisator," Mr. E. Plumley. 7 p.m. In connection with this paper, Perry Barr Stadium will be visited on Thursday, November 23rd, at 7.30 p.m.

REINFORCED CONCRETE ASSOCIATION.—20, Dartmouth-street, S.W.1. "The Decorative Treatment of Concrete Surfaces," Mr. Maxwell Ayrton. 7 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Liquid Crystals," Sir William Bragg, F.R.S. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOC. — 198, West-street, Sheffield. Discussion, "Rolling Faults in Steel," Mr. G. M. Brown. 7.30 p.m.

WEDNESDAY, NOVEMBER 22ND.

BELFAST ASSOCIATION OF ENGINEERS.—Central Hall, Municipal College of Technology, Belfast. (Joint meeting with the Inst. of Mechanical Engineers: London.) Thomas Lowe Gray Lecture, "Eight Years Salvage Work at Scapa Flow," Mr. E. F. Cox. 7.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Engineers' Club, Albert-square, Manchester. "Transmission Principles," Mr. L. H. Pomeroy. 7 p.m.

INST. OF CIVIL ENGINEERS: STUDENTS.—Great George-street, S.W.1. Address by Mr. A. S. West. 6.30 p.m.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION MEETING.—Savoy-place, Victoria Embankment, W.C.2. Mr. A. Morris will open discussion, "The Interference of Electrical Plant with the Reception of Radio Broadcasting." 6 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—At 129, Bath-street, Glasgow. "Specification Problems," Mr. A. Leitch. 7.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "The Radiographic Use of Radium," Dr. V. E. Pullin. 8 p.m.

THURSDAY, NOVEMBER 23RD.

ANNUAL CHEMICAL DINNER.—Wharncliffe Rooms, Hotel Great Central, Marylebone, N.W.1. Dinner, 7.30; dancing, 9.15 p.m.

BRITISH SCIENCE GUILD.—In Goldsmiths' Hall, Foster-lane, E.C.2. Norman Lockyer Lecture. "Empire Communication," Professor E. V. Appleton, F.R.S. 4.30 p.m.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C.2. "Recent Investigation on Telephone Interference," Messrs. W. G. Radley and S. Whitehead. 6 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "The Roller Bearing as Applied to Locomotives and Rolling Stock on Railways," Mr. P. A. Hyde. 6 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—At L.C.C. School of Engineering, Poplar, E. Lantern lecture, "Thrust and Journal Bearings," Mr. J. Hamilton Gibson. 7 p.m.

INST. OF MECHANICAL ENGINEERS: N. WESTERN BRANCH.—Engineers' Club, Manchester. Thomas Hawksley Lecture, "Kinematic Design in Engineering," Prof. A. F. C. Pollard. 7.15 p.m.

INST. OF MECHANICAL ENGINEERS: YORKSHIRE.—At Queen's Hotel, Leeds. Chairman's address, Mr. A. N. Gledhill. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Building Regulations," Mr. C. Roland Woods. 6.30 p.m.

SHEFFIELD METALLURGICAL ASSOC. — 198, West-street, Sheffield. "Applications of X-rays to Metallurgical Investigations," Mr. J. W. Rodgers. 7.30 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. Department of Mechanical Engineering. "Injection and Combustion in High-speed Oil Engines: vi., Designs of Combustion Chambers—Actual Performance—Trends of Development," Dr. S. J. Davies. 5.30 p.m.

FRIDAY, NOVEMBER 24TH.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES.—At James Watt Memorial Inst., Birmingham. "Designing for Welding," Mr. C. Helsby. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Refrigerating Machines and their Applications," Mr. W. S. Douglas. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Liquid Crystals," Sir William Bragg, F.R.S. 9 p.m.

SATURDAY, NOVEMBER 25TH.

INST. OF CIVIL ENGINEERS.—Students' visit to Erith works of Callender's Cable and Construction Company, Ltd.

MONDAY, NOVEMBER 27TH.

ENGINEERS' GERMAN CIRCLE.—At Holborn Restaurant, W.C.1. Dinner and dance. Reception, 7.30 p.m.

TUESDAY, NOVEMBER 28TH.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Grosvenor Restaurant, Gordon-street, Glasgow, C.2. Annual dinner and ladies' evening. 6.30 p.m. for 7 p.m.

WEDNESDAY, NOVEMBER 29TH.

INST. OF MECHANICAL ENGINEERS: N. WESTERN GRADUATES.—Engineers' Club, Manchester. "Tidal Power Schemes," Mr. J. L. Morden. 7.15 p.m.

THURSDAY, NOVEMBER 30TH.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOC.—Hotel Metropole, Leeds. Short paper by students for discussion. "Tramway Reconstruction," Mr. C. R. Warman: "An Economic Aspect of Reinforced Concrete," Mr. E. A. Dyer. 7.30 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Informal meeting. Mr. O. Bulleid will open discussion on "The Most Suitable Form of Traction for Main Line Railway Operation." 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—In James Watt Memorial Inst., Birmingham. "Symposium on Defects in Cold Working," arranged by Mr. A. L. Molineaux. 7 p.m.

FRIDAY, DECEMBER 1ST.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Thomas Lowe Gray Lecture, "High-speed Diesel Engines for Marine Service," Mr. H. R. Ricardo, F.R.S. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Dairy Machinery and Plant," Mr. W. Chopping. 7.30 p.m.

SATURDAY, DECEMBER 2ND.

STEPHENSON LOCOMOTIVE SOC. (MIDLANDS).—At Crumpsall Library, Manchester. "The Liverpool Overhead Railway." 6.30 p.m.

TUESDAY, DECEMBER 5TH.

CHADWICK PUBLIC LECTURES.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Rural Sanitation," Mr. J. H. Coste. 8 p.m.

WEDNESDAY, DECEMBER 6TH.

INST. OF MECHANICAL ENGINEERS: N. WESTERN BRANCH.—(Joint meeting with the Liverpool Engineering Soc., Liverpool.) Thomas Lowe Gray Lecture, "High-speed Diesel Engines for Marine Service," Mr. H. R. Ricardo, F.R.S. 7.15 p.m.

THURSDAY, DECEMBER 7TH.

INST. OF MECHANICAL ENGINEERS: N. WESTERN.—Engineers' Club, Manchester. "Factors Affecting the Grip of Force, Shrink and Expansion Fits," Mr. R. Russell. 7.15 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Properties of Concrete—A Summary of Present-day Information," Mr. J. Singleton-Green. 7 p.m.

FRIDAY, DECEMBER 8TH.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND STUDENTS.—Boots' Café, Colmore-row, Birmingham. Annual dance.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Discussion, introduced by Mr. A. Perry-Keene, "Shop Organisation." 7 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Signalling, Remote Control," Mr. Edward Wallis. 7.30 p.m.

SATURDAY, DECEMBER 9TH.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. Junior Section's social and dance. 7.30 p.m. to 11.15 p.m.

STEPHENSON LOCOMOTIVE SOC.—Headquarters, King's Cross Station, N.1. Annual general meeting, 3 p.m., Midland Grand Hotel, St. Pancras, N.1. Annual dinner, 6.30 p.m.

MONDAY, DECEMBER 11TH.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Verbesserung von Schiffsgrundrissen (Improvement of Ships' Sections)," Herr Dr.-Ingenieur Eberhard Westphal, of the Technische Hochschule, Danzig. The lecture will be followed by a technical discussion in German. 5.30 for 6 p.m.

TUESDAY, DECEMBER 12TH.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "Transmission Principles," Mr. L. H. Pomeroy. 7 p.m.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. "Notes on the Manufacture of Piston Rings and their Relation to Liner Wear," Mr. H. J. Young. 6 p.m.

INST. OF MECHANICAL ENGINEERS: N. WESTERN BRANCH, GRADUATES.—Engineers' Club, Manchester. "Bauer Wach Exhaust Steam Turbines," Mr. E. Crossley. 7.15 p.m.

THURSDAY, DECEMBER 14TH.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—The Minories, E.C.3. Film display, I., "The River Tyne," II., "The World of Machinery at the Leipzig Engineering Fiar." 7 p.m.

FRIDAY, DECEMBER 15TH.

INST. OF CHEMISTRY.—30, Russell-square, W.C.1. Fifth S. M. Gluckstein Memorial Lecture. "The Chemist as a Directing Force in Industry," Dr. Herbert Levinstein. 8 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 for 7.30 p.m.

RAILWAY CLUB.—Broad-street Station Restaurant, E.C. Annual dinner.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

RICHARD DUNSTON, Ltd., of Thorne, near Doncaster, has received an order for the construction of a steel canal barge. An order has also been received by the associated company, Henry Scarr, Ltd., of Hessle, near Hull, for a motor barge.

THE HYDRAULIC ENGINEERING COMPANY, Ltd., Chester, has received from Imperial Chemical Industries, Ltd., Billingham, an order for four 395 horse-power, high-pressure, hydraulic pumps in connection with the scheme for the production of petrol by the hydrogenation of coal.

JOHN M. HENDERSON AND CO., Ltd., King's Works, Aberdeen, have recently received contracts for two 5-ton electrically driven fixed aerial cableways for the Crown Agents for the Colonies for Hong Kong, and a 15-ton level luffing crane for the new fish docks for Grimsby Corporation.

DAVEY, PAXMAN AND CO. (Colchester), Ltd., have received an order for a five-cylinder heavy-duty oil engine of 500 H.P. for a dredger being built by W. Simons and Co., Ltd., of Renfrew. They have also in hand four eight-cylinder engines for driving paddle boats being constructed by Denny Brothers, Ltd., for the Queensferry service, and, amongst others, a 200 B.H.P. six-cylinder steel-framed engine for a shunting locomotive being made by the Hunslet Engine Company, Ltd., for the L.M. and S. Railway.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

BABCOCK AND WILCOX, Ltd., announce that Mr. Christopher S. Davy, chief engineer, has been appointed to a seat on the board.

WILLIAM GEIPEL, Ltd., Vulcan Works, 156–170, Bermondsey-street, London, S.E.1, have been appointed sole agents in this country for "Ringsdorff" arc lamp carbons.

MR. G. W. PRESTON, A.M.I.E.E., has been appointed electrical engineer to the recently formed Copper Development Association of Thames House, Millbank, S.W.1.

PETER STUBS, Ltd., Warrington, has appointed Mr. Len. B. Booth, of 29, Much Park-street, Coventry, as representative in Coventry for the sale of the firm's high-quality steels.

MR. W. A. SMITH, inventor of the "Pneuconex" grit-catching and pneumatic conveying installations, has now arranged licences with Compagnie des Transporteurs Simplex, 48, Boulevard des Batignolles, Paris, France, for use in France, Belgium, Spain, Italy, and Portugal; and from Ardeltwerke G.m.b.H., Postschliessfach 86/87, Eberswalde, Germany, for use in Germany, Russia, Holland, Turkey, and Central European countries.

A Seven-Day Journal

Science and the Nation.

Among the activities of the Association of Scientific Workers, mentioned in the newly published report of the Executive Committee, is the recent formation of the Parliamentary Science Committee referred to in our Journal note of November 3rd. Another activity is the preparation of a memorandum on the question of the inter-relation and unification of national transport. This memorandum deals with the possible construction of three ship canals across Great Britain, the reconstruction of certain of our canals now derelict, and the drainage of a very considerable area of ground in England. In this connection it may be recalled that Mr. Walton Maughan, of Holmfirth, one of the members of the Association, has studied for many years the question of cross-country ship canals, and embodied his proposals in a paper read at the Leicester meeting of the British Association. A synopsis of that paper appeared in our issue of September 22nd. During the period reviewed by the Committee's report, the Association has continued its active support of the campaign for Basic English in science and the internationalisation of scientific terms. The Committee, in conclusion, draws attention to the resolution passed at the British Association Leicester meeting urging the consideration of means by which the British Association may assist towards a better adjustment between the advances of science and progress, and the suggestion of its President, Sir Gowland Hopkins, that it may be for the scientist rather than the politician to solve the problems with which we are faced.

Coal-Oil Developments.

On Wednesday, November 15th, it was announced that a contract had been arranged between the London, Midland and Scottish Railway Company and Low Temperature Carbonisation, Ltd., for a bulk supply of oil fuel made from British coal. The first contract is for 1500 tons of oil, and is, we understand, only one of a number of similar contracts which have been arranged during the past two months by a number of important industrial firms. Since the imposition by the Government of the tax of 1d. per gallon on foreign fuel oil in April last, there has been a steady increase in the volume of the trade done by the British oil fuel industry, which, we are given to understand, is now ten times greater than it was before the duty was imposed. According to Colonel W. A. Bristow, the managing director of Low Temperature Carbonisation, Ltd., there is now an assured and profitable market for all the oil which can be produced from British coal for many years to come. Already over 100,000 tons of fuel oil and petrol have been made by the "Coalite" process, and the varied finished and refined fractions are now being marketed and are giving, it is claimed, great satisfaction. Large quantities of coal oil are now being employed in Sheffield for furnaces engaged in the production of stampings and drop forgings, while the use of such oil in specially designed glass furnaces is rapidly increasing. Arrangements for a considerable increase in the products of low-temperature carbonisation are now being concluded.

The Port of Richborough.

The announcement is made that Pearson and Dorman Long, Ltd., who are the owners of the port of Richborough, have agreed to the transference of the lease of the train ferry terminus at Richborough, formerly granted to Great Eastern Train Ferries, Ltd., to a French company for a term of years. It is expected that a new Anglo-French ferry service between Richborough and in all probability Dunkirk will be inaugurated by the Compagnie Française des Ferry Boats during the summer of 1934. The traffic will consist mainly of fresh fruit and flowers from Spain, the South of France, and Italy, which is to a large extent in the hands of the French company. From the port of Richborough the wagons will go direct, *viâ* Minster Junction, to the Bricklayers' Arms Goods Station of the Southern Railway Company, where the produce will be loaded direct into motor lorries for distribution to the various markets. The new service will be additional to that between Dover and Dunkirk operated by the Southern Railway Company.

Costing Distribution.

In an address on "Costing Distribution," which was given at Sheffield on Wednesday, November 15th, before the Sheffield Branch of the Institute of Cost and Works Accountants, Major L. Urwick, the director of the International Management Institute at Geneva, emphasised the fact that manufacturers had not put the same thought into the problems of distribution and consumption which had been devoted to questions of production. Definite steps, he thought, were needed to restore economic equilibrium, and all those steps demanded the technique of costing. The usefulness of a costing system, Major Urwick contended, depended very largely on how the information so accumulated was applied. There was no use in spending money on a costing system if the results so obtained were not acted upon in fixing selling prices. In some cases of rationalisation, companies had had an efficient costing system, but they had neglected to be guided by the figures presented to them. In many instances a great idea had been hampered by inadequate application. The economic depression which had fallen upon the world was, he suggested, not the normal sickly depression which would yield naturally in due course. It was almost a complete breakdown of the world economic machinery, which would be followed by a deeper depression unless steps were taken to put the machinery in order. Any such steps would demand application of the technique of costing and a careful study of the problems of distribution.

Thames Floods.

A Departmental Committee on Thames Flood Prevention, under Sir William Hart, was appointed in the spring of 1931, but its deliberations were suspended owing to the financial crisis, and it did not resume its sittings until just a year ago. It has just issued its report. Its terms of reference were: "To consider the present organisation for the prevention of damage by floods in the tidal portion of the Thames, and to make recommendations as to the further measures, if any, that may be necessary, as to the authority or authorities to which the duty of carrying out any such measures should be entrusted, and as to the basis on which the cost should be distributed." It now proposes that a joint committee, to decide for the whole of the tidal basin of the Thames what works of flood defence are necessary, be set up. This committee would consist of not more than fifteen members:—London County Council three representatives; the County Councils of Essex, Kent, Middlesex, and Surrey each one member; the County Borough Councils of East Ham, West Ham, and Southend jointly represented by two members; the four Catchment Boards of the rivers Lee, Medway, and Roding jointly represented by two members; the Thames Conservancy with one member, and the Port of London Authority with three members. This committee would co-ordinate the work of the existing authorities, taking into consideration such technical questions as the effect on the area of surges from the North Sea and of the land subsidence which has occurred. The execution of approved schemes prepared by it would be placed in the hands of the catchment boards and the county and county borough councils. It would have control over the whole tidal area, including the tidal length of tributaries, and would undertake a survey with a view to the preparation of proposals for such works as it might consider necessary. The distribution of the cost of flood prevention works is discussed in the report, which contemplates that the cost of some works may have to be apportioned between authorities by the joint committee, but that normally the cost of works required in an area will fall on that area.

Oil Pollution.

On Monday last the Board of Trade issued a White Paper entitled "Reports as to the Extent of Oil Pollution Round the Coast," which was prepared as the result of an assertion made in the House of Lords in May last that the evil was increasing. As a matter of fact, the Board finds that there is some diminution in the oil pollution of navigable waters round the coast, but from Kent to Dorset and in the Bristol Channel it is still severe. The information summarised in the Report was secured by means of a questionnaire sent to 134 local authorities, harbour authorities, dockyards, ports, &c., and to societies interested in the preservation of bird and fish life. Recent inquiries instituted by the Board of Trade, and embracing 1100 vessels belonging to fifty-three British shipping companies, indicate that approximately 50 per cent. of the vessels are coal burning, and do not use oil fuel or carry oil as cargo, and, therefore, separators are not required. Of the oil-burning and oil-carrying vessels reported upon, 132, or 24 per cent., were fitted with separators. The fitting of separators on board ship would not, the Board adds, provide a remedy in respect of oil discharged (1) by inadvertent discharge overboard owing to misuse of control valves; (2) through stranding; (3) through collision; and (4) possibly from vessels lost during the war years which may only now be breaking up and discharging quantities of oil.

Testing Compressed Air Cylinders.

At a meeting of the Diesel Engine Users Association on November 15th, the procedure to be adopted—if it was considered desirable to adopt a uniform procedure—for the examination and testing of air cylinders was discussed. The joint hon. secretary explained that the object of the Committee in holding the discussion was not to alarm members or because there was a considerable danger of accidents, but in order to pool experience, and, if thought desirable, to lay down broad rules for procedure. Members abroad had recently written asking for guidance about the proper maintenance routine for air cylinders, and, as the question had not been discussed by the Association since 1922, when a fire at a generating station caused a considerable amount of damage by the bursting of compressed air cylinders, a letter had been circulated to members on October 23rd last inviting them to reply to a number of questions. The replies to these questions showed what a wide diversity there was in procedure. It appeared that periodical examinations were carried out at intervals varying from three months to five years. Some members examined cylinders at irregular intervals, and some not at all. Periodical tests were carried out at intervals of from six months to five years, while 41 per cent. of the replies reported that tests were carried out at irregular intervals. When water pressure tests were applied, practice varied between a test at working pressure and twice the working pressure; 42 per cent. of members who replied said that the test and the test pressure were left to the insurance company. Only 13 per cent. reported that an internal inspection was made. Several members informed the Committee that they coated the internal surfaces of their cylinders with shellac and spirit, or a bituminous composition. In view of these replies, and of the fact that recently the British Standards Institution had drawn up specifications for air cylinders, it appeared to be desirable to draft suggestions for maintenance. The Admiralty regulations for the testing and examination were dead. After discussion it was proposed by Mr. J. G. Griffin, and seconded by Engineer Rear-Admiral Harrison, that the Committee be requested to consider the questions raised during the discussion, and if it considered action necessary to appoint a sub-committee to draw up general rules for the guidance of members.

Industrial Areas.

The remarkable fact that more than half the insured population of the United Kingdom is now to be found in the London, South-Eastern, South-Western, and Midland areas is revealed by the latest inquiries of the Ministry of Labour. In six years the total number in the South and Midlands has increased by 754,000, and in the North by no more than 312,000. The depression in the heavy engineering industries and coal mining has no doubt had some effect upon the figures. Between July, 1932, and July, 1933, the increase in the London area amounted to 33,000, in the South-East to 16,000, in the South-West to 5000, in the Midlands to 18,000, in Scotland to 6000, and in Wales to 2000. The total number of insured persons in July last was 12,883,000, and showed an increase of 75,000 in twelve months. Out of the total, 8,829,000 were men and 3,137,300 women. Figures show that the movement of men out of the depressed trades continued, particularly in general and marine engineering, shipbuilding, and ship-repairing, the displaced men entering a large variety of other trades. It is of interest to note that employment in mining and quarrying decreased by nearly 14 per cent. in the ten years preceding 1923, whilst in transport, communications, storage, and distribution it augmented in the same period by no less than 42·6 per cent. Since in the same decade the number of insured persons in the manufacturing industries rose by no more than 5·3 per cent., we have a clear indication of the importance which distribution now takes in the economy of the nation.

A Compressed Gas Filling Station.

An event of considerable interest to the road transport industry took place at the works of the Chesterfield Tube Company, Ltd., at Chesterfield, on Wednesday, November 15th, when the first public filling station for gas-driven vehicles was formally opened by Mr. Ernest Brown, the Parliamentary Secretary for Mines. Mr. Brown was introduced by Mr. W. A. Woodeson, the chairman of the company, who briefly referred to the economies which were to be gained by running on compressed gas. The plant comprises the four-stage electrically driven Bryan Donkin gas compressor which was exhibited at the last British Industries Fair at Birmingham. It supplies compressed gas of about 480 B.Th.U. calorific value to three storage cylinders at a rate of about 100 cubic feet per minute and at a pressure of 5000 lb. per square inch. Suitable pressure governing devices for charging the gas cylinders of the transport vehicles are provided, and it was demonstrated that refilling could be quickly and simply accomplished. In the course of his speech at the luncheon which followed the opening ceremony, Mr. Ernest Brown paid a tribute to the pioneer research work which had been done by the Chesterfield Tube Company, Ltd., and Vickers-Armstrongs, Ltd., in the production of light high-pressure steel vessels for gas storage. He expressed the hope that the station he had opened would be the first of a whole chain of filling stations covering the country and serving industry, and suggested that colliery companies and allied industries should convert a proportion of their vehicles to utilise compressed gas instead of petrol fuel, and thus enable further improvements to be made in compressed gas distribution. During the day many of the visitors, of which there were about 200 present, had an opportunity of witnessing for themselves the manufacture and testing of high-pressure steel cylinders and tubes for industrial and marine engineering uses.

Recent Hydro-Electric Power Plants in Sweden.

No. III.

(Continued from page 484, November 17th.)

THE KRANGEDE WORKS.

THE co-ordination of electric power resources, apart from national or State organisation, has nowhere been carried out more effectively than in Sweden. A well-known instance of such co-operation is the Bergslagen Co-operative Power Corporation formed for the purpose of exploitation and distribution of electric power in that part of Central Sweden called Bergslagen. Another example of co-operation between otherwise independent industrial and public utility interests for the joint exploitation of a very large source of power is the Krangede scheme, the object of which is to profit both from the technical and economic advantages, which can only be attained by large-scale power production, without sacrificing independence in respect of power supply. The difference between this co-operative enterprise and other large power undertakings is chiefly a matter of organisation.

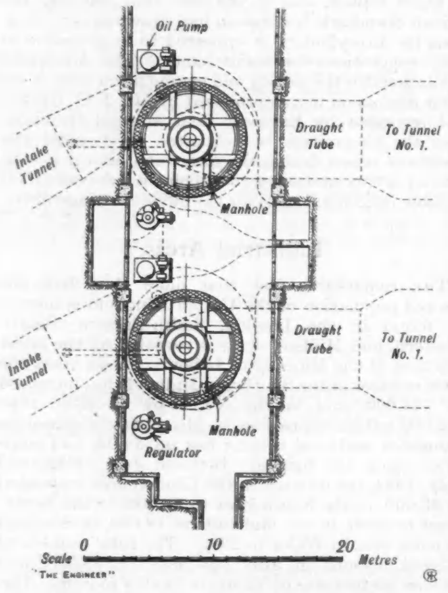
Oil Pump
Draught Tube
To Tunnel No. 1.
Intake Tunnel
Manhole
Draught Tube
To Tunnel No. 1.
Intake Tunnel
Regulator
Manhole
Scale
0
10
20
Metres
"The Engineer"

FIG. 23—PLAN VIEW OF GENERATOR HALL

It was foreseen more than twenty years ago that the power resources of Bergslagen, as well as of the adjacent industrial regions of Central Sweden, would be insufficient in the near future. With the development of long-distance transmission of electric energy the idea of making use of a remote supply of water power became more than a possibility. On the initiative of Mr. Sven Lübeck, now the Governor of the Province of Gävleborg, five ironworks in Central Sweden, in 1916, purchased the rights in the Krangede Waterfalls, one of the biggest in Sweden. The falls are in the Indal River in the Province of Jämtland, North Sweden, about 350 kiloms. north of the prospective load centre. The purchasers of the power rights were afterwards joined by the Bergslagen Power Company and at the present time the partners in the undertaking are three iron and steel works—Sandviken, Fagersta, and Hofors—the Korsnäs Saw Mills, the Bergslagen Power Company, and the City of Stockholm. The Krangede enterprise is organised in the form of a joint stock company, the individual shareholders owning an approximately equal number of shares. The power will be allotted to the shareholders in proportion to the shares owned and will be paid for at a price corresponding to the company's own production cost. It is of special interest to note that the production cost is not to be allocated in proportion to the maximum demand only, but that a certain, although very small, kWh charge is to be paid corresponding to the value of energy for steam generation and other similar power supplies. This charge is to vary with the cost of coal, but will be not less than 0·2 ore per kWh (1 ore=approximately ⅛d.), with 100 per cent. rise during low-water periods. The remainder of the energy charge is in proportion to the demand. Any energy not required by a shareholder for his own business will be offered to the other shareholders in the company before any sale of such energy to outside parties is arranged. Apart from the general power agreement between the shareholders, separate and special power contracts may be made between the company and its individual shareholders. Such a contract has already been concluded with the City of Stockholm, which, in addition to its full share of power, has subscribed for 4000 kW at the company's cost price. The contract also contains stipulations to the effect that any surplus energy from the Krangede plant shall first be placed at the disposal of the city and the latter shall supply the company with stand-by power from its large steam power plants.

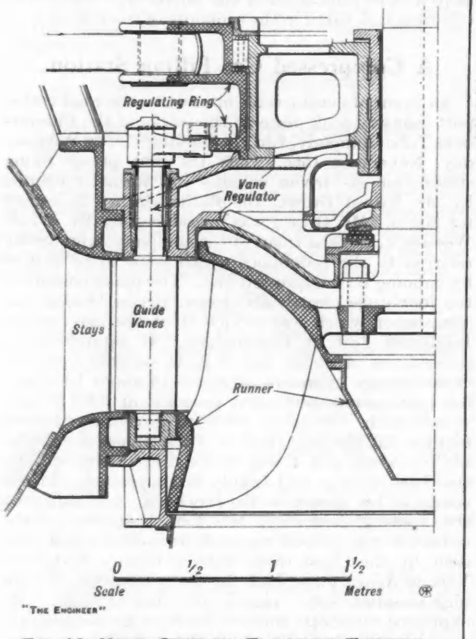
Regulating Ring
Vane Regulator
Guide Vanes
Stays
Runner
0
½
1
1½
Scale
Metres
"The Engineer"

FIG. 24—HALF-SECTION THROUGH TURBINE

The construction of the Krangede works was begun in 1931 and the first section of the plant is expected to be completed in 1936. This section comprises two vertical turbine units of 35,000 kW each, and the plant, when fully developed, will consist of six such units or a total of 210,000 kW. A transmission line for a voltage of 220 kV is to be constructed from Krangede to Horndal in Bergslagen over a distance of 340 kiloms.—see plan, Fig. 26. At Horndal a substation for 200/70 kV is to be erected from which a distributing system for 70 kV is to be fed. Stockholm's share is to be drawn at 200 kV at Horndal, and by a line for the same voltage, owned by the city, transmitted to the capital, which is 450 kiloms. from Krangede in a direct line.

THE POWER PLANT.

A dam, 220 m. in length and 18 m. in height, is now being constructed across the river at the head of the Krangede Falls. The dam is of a modified gravity type, which we shall describe hereunder. It is to be provided with four large gates, viz., three Taintor gates and one sector gate, each 20 m. in width and about 7 m. in height. The Taintor gate openings are intended for the discharge of flood water, whereas the sector gate has the additional purpose of passing timber logs floated down the river. The sector gate is of the hydraulically counterbalanced type, which has been successfully used in several hydro-electric power plants in Sweden and which has previously been described in English technical journals. The river will be dammed to the level of Lake Gesunden, which, covering an area of about 30 square kilometres, will serve as a reservoir for water regulating purposes. The geological formation at the Krangede Falls consists chiefly of grey and reddish granites and syenites, which are closely interconnected and therefore may be termed granite-syenite. This is in some places intersected by a dark basic rock, diabase. At the site of the dam the rock is bare and is nowhere overlain by soil, except to a depth of a few feet, in any part of the river bank where the works connected with the dam are being constructed. From the intake, designed as an extension of the dam on the left bank of the river, the water will be passed through vertical shafts, excavated in the rock, to the turbines, which, together with the generators, will be installed in an underground machinery hall, likewise excavated in the rock. The floor of the turbine room is about 57 m. below the intended water level at the back of the dam and 47 m. below ground level. The first section of the works includes three separate intakes and penstock shafts; one set for each turbine, two of which will be installed at present.

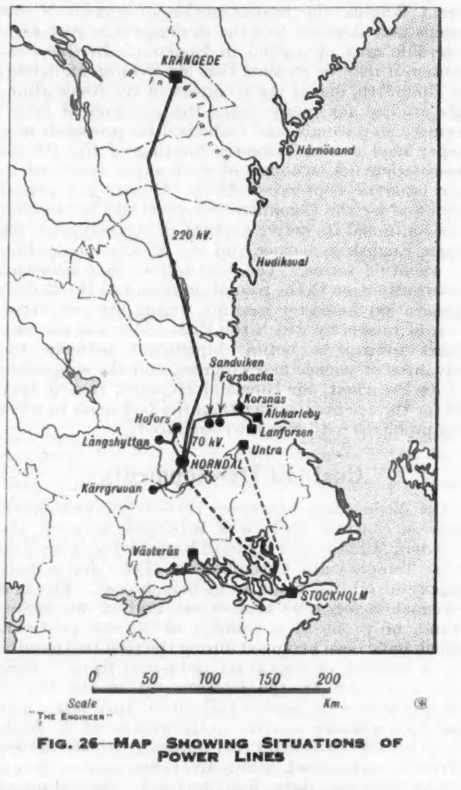
KRÅNGEDE
Härnösand
220 kV.
Hudiksval
Sandviken
Forsbacka
Korsnäs
Älvkarleby
Lanforsen
Hofors
Långshyttan
70 kV.
Untra
HORNDAL
Kärrgruvan
Västerås
STOCKHOLM
0
50
100
150
200
Scale
Km.
"The Engineer"

FIG. 26—MAP SHOWING SITUATIONS OF POWER LINES

DISCHARGE TUNNEL.

The water discharged from the two draft tubes of the turbines flows into a large tunnel, 1400 m. in length, driven through the rock to an exit on the left bank of the river below the rapids. This tunnel (Figs. 25 and 27), constructed entirely in rock, is 13·4 m. high and 11·0 m. wide, and has a cross-sectional area of about 116·0 square metres, larger than that of any discharge tunnel so far driven in rock. Its floor at the upper end is at level +137·0 m. or 67 m. below the dam water level. The level of the invert at the tunnel outlet is +135·5. Tunnelling was begun at the lower end near, but just inside, the river bank, which will be cut through when the tunnel works are completed. The rock excavated from the tunnel is run to a spoil bank extending along the

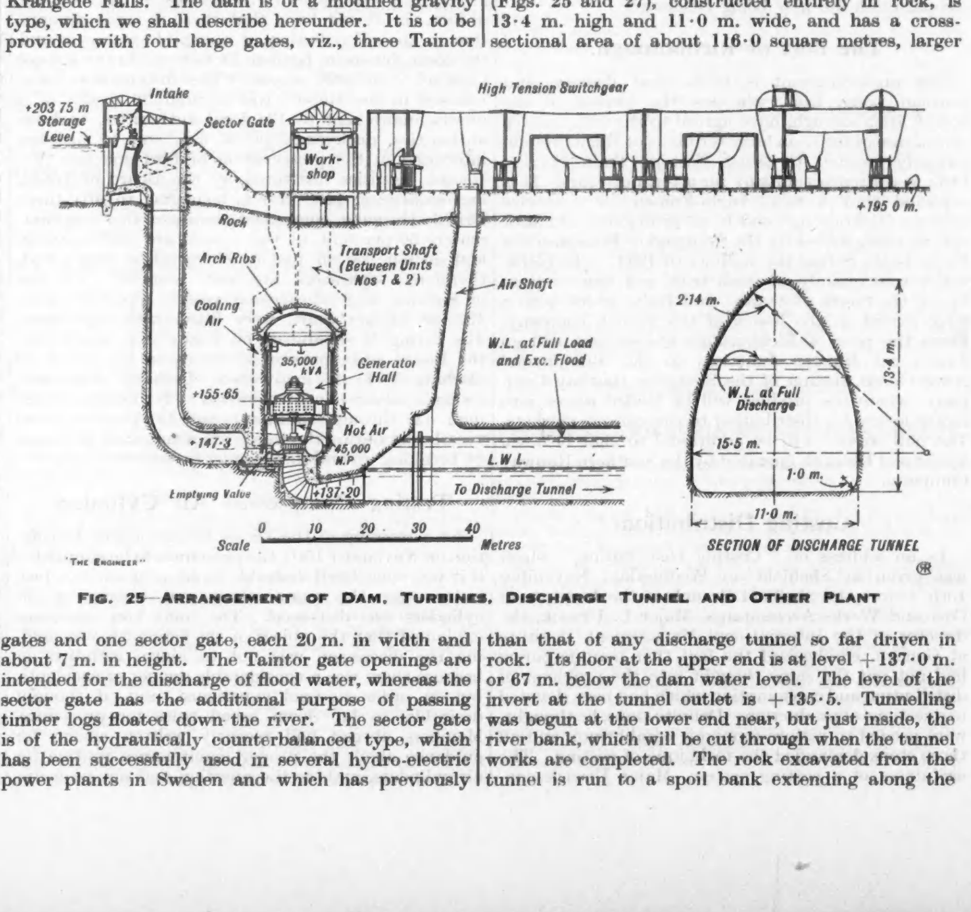
Intake
+203 75 m Storage Level
Sector Gate
Work-shop
High Tension Switchgear
+195 0 m.
Rock
Arch Ribs
Transport Shaft (Between Units Nos 1 & 2)
Air Shaft
Cooling Air
35,000 kVA
Generator Hall
W.L. at Full Load and Exc. Flood
+155·65
Hot Air
45,000 H.P
+147·3
L.W.L.
Emptying Valve
+137·20
To Discharge Tunnel
0
10
20
30
40
Scale
Metres
"The Engineer"
2·14 m.
13·4 m.
W.L. at Full Discharge
15·5 m.
1·0 m.
11·0 m.
SECTION OF DISCHARGE TUNNEL

FIG. 25—ARRANGEMENT OF DAM, TURBINES, DISCHARGE TUNNEL AND OTHER PLANT

bank of the river below the outlet. The rock in which the tunnel has been driven is compact and hard. In only a few places has any timbering been necessary to support small areas of the roof. It is not proposed to line the tunnel, except in those few positions where loose rock is met with. As we have already indicated, this tunnel will serve for the discharge from three turbine sets, two of which will be installed in the first instance. When the fourth unit of the plant is constructed, the provision of a second tunnel will be necessary, which will ultimately serve for the discharge of the remaining three units. The maximum water discharge from the draft tubes of the first pair of turbines will be 140 cubic metres per second, and the corresponding mean velocity in the tunnel about 1·8 m. per second. An interesting feature of the tunnels is that the roof is elevated so that the tail water level will always be free. A special surge chamber is therefore not required in this case. Precautions are, of course, taken to safeguard the works, if, under certain exceptional conditions and by a sudden and great increase of load during exceptionally high tail water level, the tunnel should be filled and a heavy rise of pressure in the tunnel occur.

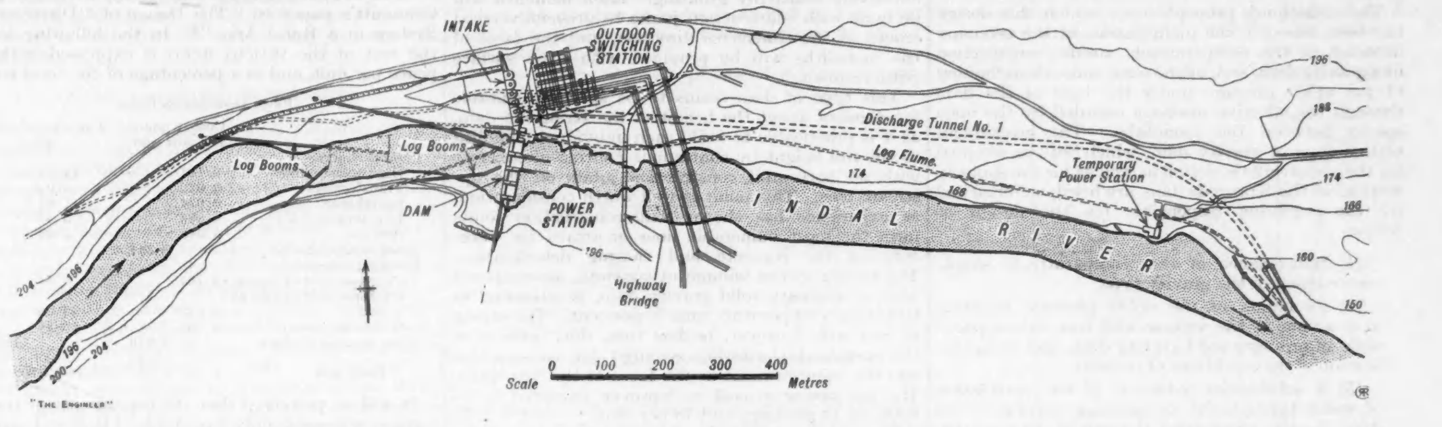

FIG. 27—DETAIL MAP SHOWING SITUATION OF DAM, POWER STATION AND DISCHARGE TUNNEL

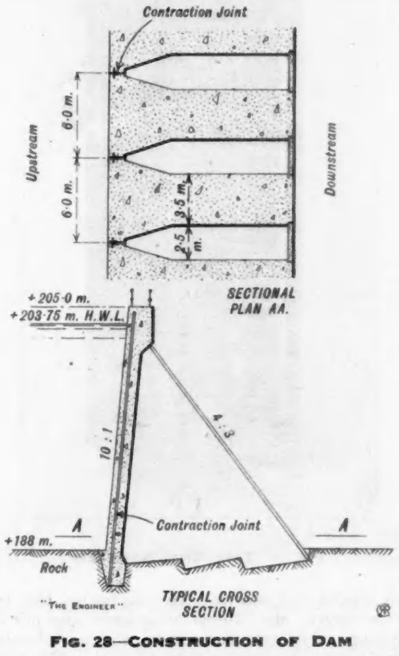

FIG. 28—CONSTRUCTION OF DAM

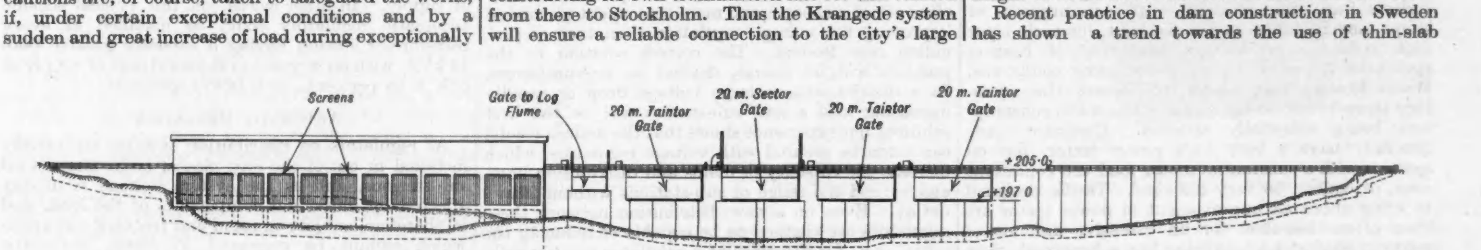

FIG. 29—GENERAL ELEVATION OF UPSTREAM FACE OF DAM

All drilling in the tunnel is done by compressed air. The rock *débris*, after blasting, is removed by an electrically driven Bucyrus excavator, and loaded into wagons, which are hauled by electric locomotives to the spoil dump. At the present time (August, 1933) about half the length of the tunnel has been opened out to the full section and the pilot heading has been driven through to the shafts at the power station.

POWER STATION.

The available gross head of water at the power station is about 60 m. The turbines (Figs. 23, 24, 25,) will be of the vertical shaft, single-runner Francis type, mounted in steel spiral casings; each will have a rating H.P. of 45,000. The normal water consumption of each turbine is to be 55 cubic metres per second at 57·7 m. head. Under these conditions the guaranteed maximum efficiency is 92 per cent. At 70 cubic metres per second discharge and the same head, the turbine will develop 47,400 H.P. The speed is 166·7 r.p.m., and the head will vary between 54 m. and 60·5 m. The runners are of cast steel and 3·5 m. diameter. The generators (Figs. 23 and 25), to be coupled direct to the turbines, are rated at 35,000 kVA, 10 kV, and 50 p/s. Each generator is to be connected to a three-phase self-cooled transformer for 35,000 kVA and 10/220 kV. The transformers and the high-tension switchgear are to be located out of doors (Fig. 27). The 10-kV bus-bars will feed the station service transformers and also a transformer for about 15,000 kVA at 10/70 kV, which will connect the station to the Hammarforsen hydro-electric power station, situated on the Indal River, some 18 kiloms. below Krangede. The generators and main transformers are being constructed by the Allmänna Svenska Elektriska Aktiebolaget (ASEA), Västeras, and the turbines by the Karlstads Mek. Verkstad, Kristinehamn.

TRANSMISSION LINES.

The 220-kV transmission line (see Fig. 26) between Krangede and Horndal, 340 kiloms., will be equipped with steel towers and copper conductors of 3 × 240 square millimetre section. At the Horndal substation two transformers, rated at 30,000 kVA and 200/70/10 kV, will be installed. The 10-kV winding is for the connection of reactors and synchronous condensers. The secondary lines are designed for 70 kV, and will be equipped with wooden poles and copper conductors, mostly of 3 × 70 and 3 × 95 square millimetre section. One of these lines will connect the system to the Lanforsen power station, jointly owned by the City of Stockholm and the Sandviken Ironworks, and also to the state power station at Alvkarleby. Another line will make connection with a projected 70-kV line, Västeras–Krylbo, in the State power distribution system.

The City of Stockholm will receive its share of power at 200-kV tension at the Horndal sub-station, constructing its own transmission line for this tension from there to Stockholm. Thus the Krangede system will ensure a reliable connection to the city's large steam power station at Värtan, which has an installed machinery capacity of some 100,000 kW.

THE DAM.

The foundations on the south side of the river have already been constructed, and a portion of the dam built (Fig. 27). On the north side the building of the intake and abutments is in progress. The overall length of the dam, including the intakes, is 350 m. (Figs. 27 and 29). A 5-tons aerial ropeway for constructional purposes spans the river at the dam site.

The most difficult portion of the dam construction —the building of that part which will cross the swift-flowing stream in the rapids—is to be carried out in accordance with the following programme, which is based on the experience gained in the construction of the cofferdam for the Hammarforsen station in 1926. During the low water period in the winter of 1933–34, the north half of the dam will be enclosed by a wooden cofferdam, and within this three piers (but not the overflow weir) will be concreted. The second stage of construction—covering the low water period in the winter of 1934–5—includes the building of a similar cofferdam enclosing the other half of the dam and the concreting of the dam structure within it with the exception of two 6 m. monoliths of the non-overflow portion. In the meantime, the river discharge will be through the openings left between the piers built in the 1933–34 season. The work to be carried out in the third stage of construction during the winter of 1935–6 includes the successive closing of the openings in the dam left for the discharge of the river flow, the concreting of these weir sections between the piers built in 1934, and the concreting of the two remaining monoliths of the non-overflow portion of the dam. The dam will have a maximum height of 18 m. above the rock in the river channel.

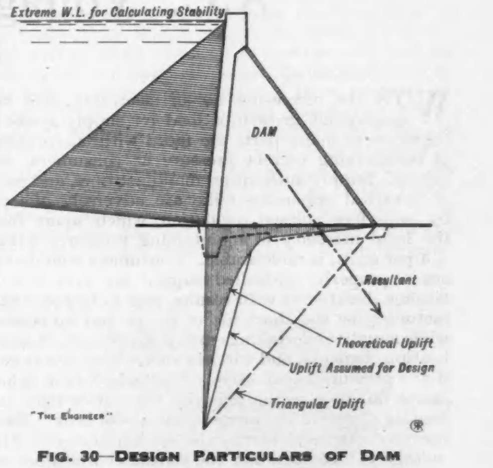
Extreme W.L. for Calculating Stability
DAM
Resultant
Theoretical Uplift
Uplift Assumed for Design
Triangular Uplift
"The Engineer"

FIG. 30—DESIGN PARTICULARS OF DAM

Recent practice in dam construction in Sweden has shown a trend towards the use of thin-slab hollow dams of the buttressed type. At Krangede, however, the abundance of hard rock material available from the permanent works of the tunnel and shafts favoured mass concrete construction for the dam. The modified type of gravity dam which has been adopted is said to compare favourably with an ordinary solid gravity dam. A typical cross section and a part-sectional plan of the non-overflow portion of the dam on the right-hand side of the river, are shown in Fig. 28. The structure might be described as a laminar gravity dam, consisting of a number of vertical monoliths or piers, each 3·5 m. thick, and widening at the upstream end into a bulkhead 6·0 m. thick. The monoliths are placed at a distance apart of 6·0 m., centre to centre, thus leaving a free space of 2·5 m. width between the sections. The joints between the bulkheads serve as contraction joints, and each will be closed by a special sealing device.

The underlying principle upon which this design has been based is the maintenance of the economy inherent in the comparatively simple construction of a gravity dam, and, at the same time, the reduction of the uplift pressure under the base of the dam through the effective drainage afforded by the open spaces between the monoliths. The advantages of this type of gravity dam, which will be adopted for the non-overflow section as well as for the spillway sections of the Krangede dam, are briefly summarised by the engineers responsible for the design as follows:—

(1) Maintenance of the comparatively simple construction of the gravity type.

(2) Reduction of the uplift pressure resulting in a saving in the volume and cost as compared with an ordinary solid gravity dam, and in simplification of the conditions of stability.

(3) A substantial reduction of the percolation of water through the downstream portion of the dam, thereby eliminating the risk of deterioration in this part of the structure. Experience has shown that this is of importance in regard to the character of Swedish river waters.

(4) Facilitated inspection, and, if necessary, repair of the concrete.

(5) The prevention, as far as possible, of the formation of shrinkage and temperature cracks in the concrete by allowing each monolith to dilate independently of adjacent monoliths.

(6) Facilitated control of the generation and dissipation of the chemical heat in the concrete.

The uplift pressure assumed for the design is shown diagrammatically in Fig. 30. To prevent any undue uplift resulting from horizontal fissures or seams in the rock under the foundations, it is intended to drill wells into the rock from the open spaces between the monoliths and behind the cut-off trench, the rock under the trench having previously been effectively sealed by grouting. Each monolith will be built with construction joints to prevent vertical cracks in the transverse direction, and the faces of the monoliths will be provided with some surface reinforcement.

This type of dam seems to be specially suitable for dams of about the height of the Krangede dam, as it is practicable to build each individual monolith to the full height by continuous pouring of concrete with no horizontal construction joints on the upstream face. This point is well worth consideration, as experience has shown that construction joints form the most vulnerable lines of attack for water entering the concrete and causing deterioration. The saving in the volume of concrete, as compared with an ordinary solid gravity dam, is estimated to be between 20 per cent. and 30 per cent. The saving in cost will, however, be less than this, because of the increased shuttering required for construction and the reinforcement at the faces of the monoliths. The net saving in cost is, however, expected to be between 10 per cent. and 15 per cent.

The total cost of the first development of the Krangede power plant, with the intake and discharge tunnel completed for three units and the power station for two machinery units, including civil engineering works, machinery in the power station, and step-up transformers, is estimated to be 22 million Swedish kronor (about £1,120,000).

The consulting engineers for the Krangede works are Vattenbyggnadsbyran (VBB) of Stockholm.

(To be continued.)

A.C. Voltage Regulators.

No. I.

With the increasing use of electricity, and the consequent growth of load on supply systems, engineers in many parts are faced with the problem of maintaining correct pressure at consumers' terminals. Supply authorities, manufacturers, and users of electrical apparatus alike are adversely affected by imperfect voltage regulation, which, apart from the legal necessity of maintaining pressures within ±4 per cent., is undesirable. Consumers who do not get a properly controlled supply are very apt to become dissatisfied with results, and to blame manufacturers for the short life of lamps and apparatus, while supply undertakings may lose revenue. Lamps, heating elements, and wireless valves soon deteriorate if the pressure is excessive. Conversely, if it is low, lamps fail to give the requisite amount of light and heating elements the proper quantity of heat. Mains operated wireless sets may also work imperfectly if the voltage is incorrect, and the consumer who does not realise what is wrong may tell his friends not to purchase a set of the same make as his own. Similarly, users of electric cookers and heaters may do no end of harm by spreading the idea that electric heating and cooking leave much to be desired. Adequate voltage is, of course, essential to secure the best performance from electric motors, although this is a matter of greater importance in the factory than in the home.

As regards the effect of low voltage on supply undertakings, the reduced watt consumption of lamps may be taken as 1·5 per cent. for each 1 per cent. reduction in voltage, and that of heating apparatus 2 per cent. under the same conditions. Water heaters take longer to impart the necessary temperature to the water without the consumption being materially affected. Domestic loads generally have a very high power factor, but on systems with a substantial motor load the conditions may, of course, be very different. Tariffs designed to bring about an improvement in power factor are then often desirable, for an excessive amount of wattless current has anything but a beneficial effect on voltage. By basing the charge on the kVA demand, large consumers are encouraged to install motors which do not draw a lagging current, or to provide special power factor correcting devices, such as phase advancers and condensers. Power factor improvement, however, scarcely comes within the scope of these articles, although it is important to be certain when applying regulators to distribution systems that the magnetising kVA and leakage reactance of the apparatus are not unduly heavy. There is a tendency, we find, on the part of some manufacturers to criticise their competitors' goods on these and other grounds, but supply engineers must be left to specify exactly what they require, and to ensure before purchasing a regulator that it will have reasonably low losses and magnetising kVA, and that it will be capable, if necessary, of working satisfactorily on a low power factor load.

Much can, of course, be done to secure a steady voltage by correctly choosing the lay-out of mains, feeders and sub-stations, but notwithstanding careful design the voltage control problem exists on many networks. In some cases the load has grown much more rapidly than was expected, and in consequence of consumers' complaints steps have had to be taken to improve the voltage regulation without delay. Variations in pressure at consumers' terminals may be due to one or a combination of three main causes, *i.e.*, bulk supply variations, distribution drop, and out-of-balance loading.

Regulator Advantages.

Articles on A.C. regulators appeared in The Engineer during April and May, 1926; and on "on-load" transformer tap-changing gear (which can, of course, be applied to distribution transformers) during July and August of 1929; but within more recent times there have been new developments, and the demand for distribution regulators has become more widespread. In some cases it has been found necessary to employ some kind of voltage control apparatus which operates automatically. Such regulators may be installed rapidly without interfering with existing arrangements, can be kept in stock ready for use when they are required, and they often afford a cheaper and more convenient method of improving the voltage regulation than that of providing new feeders. The correct solution to the problem will, of course, depend on circumstances. In a district with a large voltage drop or rapidly increasing load a new sub-station will be the best solution, but experience shows that the desired results can often be secured with voltage regulators, which increase the capacity of mains and distribution lines, and extend the range of sub-stations without heavy outlay. Even on a new distribution network these regulators are claimed to be capable of reducing the initial cost, for the price of a regulator is practically negligible, compared with that of feeders and sub-stations. On new and existing networks regulators may be installed permanently or temporarily, according to the growth of load. Where the load is steadily increasing and new feeders and sub-stations will ultimately be required, regulators may be employed to maintain the pressure for a certain time. Under these conditions the economic case for regulators becomes a matter of comparison between the annual total cost of the apparatus and the saving in the capital cost of new sub-stations and mains.

The Economic Aspect of Automatic Voltage Regulators.

Although the cost of a distribution regulator such as an on-load tap-changing regulator may be as great or even greater than that of a transformer with which it is associated, the saving in the cost of distribution lines and cables, due to the greater permissible voltage drop, or, alternatively, the increase in permissible loading of existing lines and cables, when automatic regulation is adopted, may easily make this a matter of no importance. This was shown some time ago in a paper read before the Overhead Lines Association, by Mr. E. T. Norris, who analysed the model scheme rural distribution developed in Messrs. Dickinson and Grimmitt's paper on "The Design of a Distribution System in a Rural Area."* In the following table the cost of the various items is expressed both in pence per unit, and as a percentage of the total cost:

Rural Distribution Costs.

	Cost in pence per unit sold.		Per cent. of total cost.	
Capital charges—				
High-tension lines	0·181		14·84	
Transformers	0·025		2·05	
Switchgear	0·024		1·97	
Low-tension lines	0·066		5·43	
Services	0·048		3·92	
Total capital charges		0·344		28·21
Running charges—				
Purchase cost of losses	0·104		8·54	
Purchase cost of energy sold	0·586		48·00	
Overhead costs	0·186		15·25	
Total running charges		0·876		71·79
Total cost	1·22	1·22	100·0	100·0

It will be perceived that the capital cost of transformers represents only 7 per cent. of the total capital charges and only 2·05 per cent. of the total cost of supplying energy. Hence it is clear that even if regulators are as expensive as transformers there is no reason for alarm. To emphasise the point more strongly, Mr. Norris considered the effect of equipping every transformer on the model scheme having a capacity greater than 15 kVA with an automatic regulator, a scheme which would make the total cost of the regulators one-third of that of all the transformers. Thus the capital cost of the regulators would be 0·33×7·3=2·4 per cent. of the total capital charges, or 0·33×2·05=0·68 of the total cost of supply. In other words, on this typical scheme automatic regulators could be installed at every transformer station having a capacity greater than 15 kVA, with an increase in the total cost of supply of only 0·68 per cent., or 0·0082d. per unit.

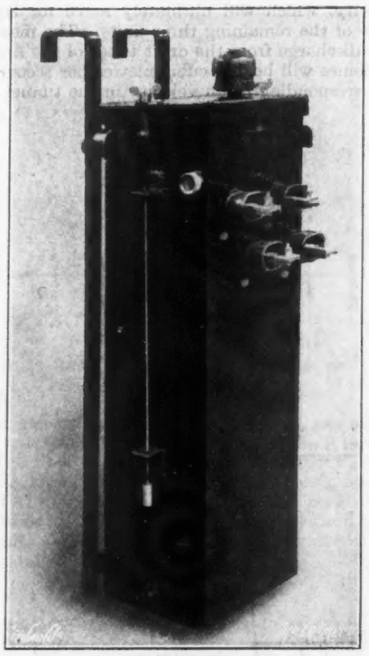

Fig. 1—Tail End Booster

Automatic Operation.

As regulators on distribution systems are usually installed in out-of-the-way places, or in unattended sub-stations, and as the system voltage is usually affected by individual components of the load, and is, therefore, subject to rapid and frequent variations which cannot be corrected by hand, automatic regulation is generally essential. But on large transformers handling a bulk supply the single components of the load are sufficiently numerous to have negligible individual effect on the voltage, and the regulating gear need only be operated infrequently as the load rises and falls. On-load tap changing equipments must, of course, be associated with transformers. It can, however, be applied to transformers with outputs as low as 100 kVA with small increase in the overall dimensions, and with negligible increase in the losses. But while it is fairly simple to design a multi-way switch suitable for infrequent tap changing, it is not so easy to make open-type switches or contactors which will last for long periods under automatic operating conditions involving, perhaps, several hundred operations per day without renewal adjustment and cleaning. Small self-contained automatic regulators suitable for any number of operations are suitable for distribution circuits, for they can be installed in any desired position. Irrespective of the input voltage or of whether the variations are due to load passing through the regulator, or to drop in the high-tension lines or other parts of the network, the automatic control gear can be set to maintain a constant output pressure. Moreover, if necessary, the regulators may be compounded in order that the voltage may increase with the load.

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* *Journal* I.E.E., Vol. 70, page 234.

Current-operated Regulators.

Regulators such as the Ferranti patented current operated tail end booster, shown in Figs. 1 and 2, increase the voltage in proportion to the load passing through them. They are cheaper than the firm's independent voltage regulators, and have the additional advantage that in some cases at no-load the losses are zero. Notwithstanding that they will only compensate for voltage variations due to their own load, they have a wide range of application, although it is important when installing regulators to consider the cause of the voltage variations that are being experienced. Regulators can, of course, compensate for drop in transformers as well as in cables and overhead lines, and if desired transformers can, therefore, have greater reactance and lower short-circuit currents. Small transformers then become cheaper. Similarly, less expensive switchgear may be employed owing to the reduced short-circuit current, particularly in the case of cable distribution.

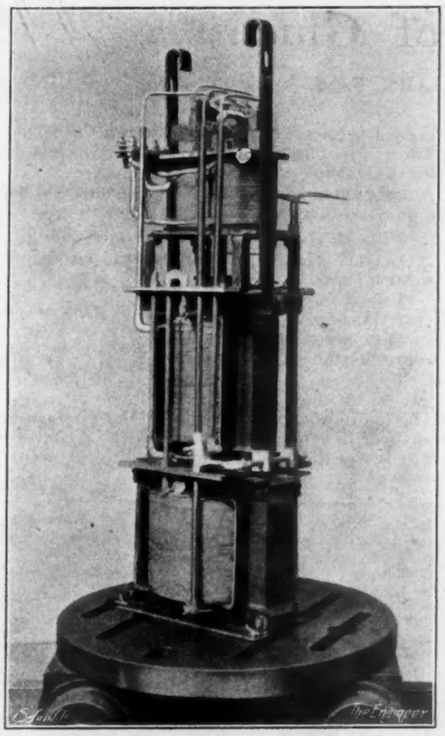


Fig. 2—Tail End Booster Removed from Case

One of the special features claimed for the patented tail end booster made by Ferranti Ltd., of Hollinwood, Lancs., is that as it does not demand the use of a sensitive voltage relay, the relative infrequency of operation, as compared with voltage-controlled boosters, permits of much larger voltage steps. The standard tail end booster gives a 6 per cent. boost in two 3 per cent. steps, the first coming into operation at about half-load, and the second at about three-quarters load, but larger or smaller steps can be provided if desired. A small transformer, a reactor, and two solenoid-operated mercury tube switches constitute the complete equipment, which is oil-immersed in a common tank, suitable for outdoor service. In the no-boost position of the regulator there is an absence of no-load losses, and since this is usually the condition prevailing during the majority of the working hours, this feature is considered to be one of considerable importance.

The increase in load that is made possible on an existing distributor by the installation of a tail end booster depends on the point at which the additional load is to be connected. If the new load is distributed along the existing line and no extension is necessary, the increase is estimated by Ferranti, Ltd., at about 67 per cent., but even if the new load can only be obtained by extending the line, the increase is unlikely to be less than 30 per cent. On a long distributor these cheap tail end boosters may be inserted at suitable intervals, but the number which may be employed is limited to two or three. When such boosters are used in series theory indicates that the amount of boost should be graded, each booster giving approximately two-thirds of the boost of the preceding unit. The third booster will, therefore, give less than half the boost of the first and the lack of standardisation will be inconvenient. On the other hand, if a standard boost is employed, the increase in load allowed by the addition of each succeeding booster becomes rapidly smaller unless the maximum voltage variation is allowed to increase. Under current control the frequency of operation is so low that a much larger voltage step is allowable and the number of steps necessary is correspondingly reduced. When the number of steps is limited to two great simplicity is secured, as interlocking can be almost completely eliminated.

Although the separate phases of a three or four-wire unbalanced circuit may be regulated individually by using the necessary number of independent single-phase units, it is preferable and generally no more costly to employ a three-wire single-phase or polyphase booster in conjunction with a separate static balancer. As in general the most suitable position for the former is farther from the substation than that of the latter, it is recommended that the two units should be kept distinct. As the load grows on a three-wire single-phase or four-wire three-phase distributor, a condition is reached under which the voltage at the tail end falls at times to the minimum allowable, and if this fall is largely brought by drop caused by an unbalanced load, the installation of a static balancer may permit of about 25 per cent. increase in load before the voltage again falls to the minimum permissible. The next step in the development of the system may be the installation of a tail end booster, which, if placed in the ideal position at the outset, will call for no further attention. This ideal position depends on the final conditions when the limit of voltage drop is reached.

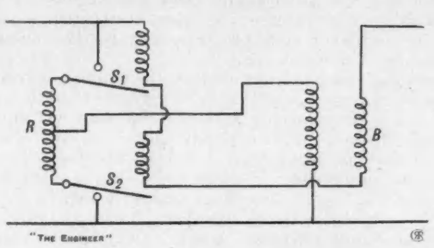


Fig. 3—Tail End Booster Connections

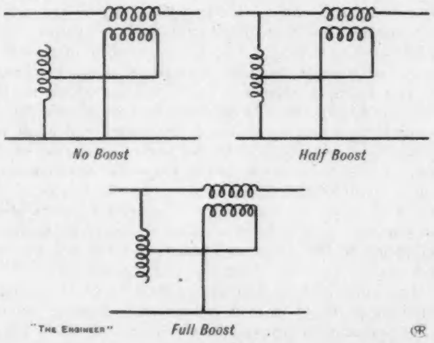
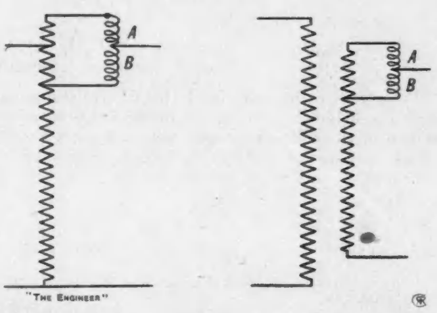


Fig. 4—Tail End Booster Step Connections

If the full allowable drop is, say, 9 per cent., and the boost 6 per cent., the limiting condition will be reached when the total drop is 15 per cent., and this condition can only be dealt with satisfactorily if the booster is placed at the point at which the drop is 9 per cent. If it is too near the sub-station, consumers immediately beyond it will at times receive too high a voltage, while if it is too far out, consumers immediately preceding it will get insufficient voltage. Before installing a tail end booster it is desirable to consider what the final distribution of load is likely to be, and at what point the unboosted voltage will first reach the minimum allowed. If at the time of installation the information available is insufficient to enable such an estimate to be made, the makers of these boosters recommend that the apparatus should be installed in the first instance at the point at which the maximum voltage drop is two-thirds of that at the tail end of the distributor.



Figs. 5 and 6—Auto and Double Winding "Apex" Regulators

The two solenoid-operated switches used on the primary side of these boosting transformers are of the mercury tube type. Similar switches have undergone full load life tests of two million operations, and have been successfully used for some years on automatic tap changing gears operating between 200 and 300 times a day. It is well known that these switches have no open contacts, and as they need no maintenance, they are immersed in the oil-filled tank together with all the other apparatus. The switches used are capable of dealing with the short-circuit current of the distributor. A "bridging impedance" is employed to prevent the opening of the circuit during the operation of the switches, and it also acts as a 2/1 auto-transformer to give the intermediate 3 per cent. boost.

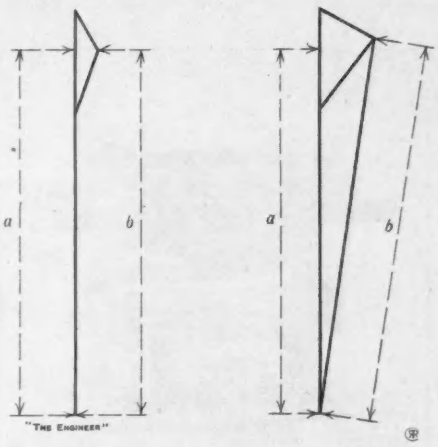


Fig. 7—"Apex" Regulator Vector Diagrams

Principle of Operation.

A two-wire single-phase unit is shown in Fig. 3, in which B is the booster transformer, with its secondary winding in series with the line. R is the tapped reactor, and S_1 and S_2 the mercury switches, the former being arranged to close at half load and the latter to open at about three-quarters load. Although the operating coils of these switches are normally fed through a current transformer, for the sake of clearness they are shown connected directly to the circuit. At light load, when both plungers are in the lowered position, only switch S_2 is closed, and it short circuits the primary winding of the booster through part of the reactor winding, as shown in the top left-hand diagram of Fig. 4, with the result that the line does not receive a boost. When, however, the load reaches a value that necessitates a rise in the tail end pressure, the switch S_1 closes, and connects the full reactor winding across the supply, as shown in the top right-hand diagram, Fig. 4, so that it acts as an auto-transformer and applies half voltage to the primary and thus causes the booster to give half the maximum boost. When the load increases still more, the switch S_2 opens and leaves the primary connected across the line, so that it receives full pressure and the booster gives the maximum boost, as indicated in the lower diagram—Fig. 4. As the load falls, the switch S_2 closes first and later S_1 opens, the two switches being interlocked so that they cannot open simultaneously. Means for setting the operating current of each switch to suit circuit conditions are also provided. The kVA of a tail end booster is the maximum load which can be passed through it, but as the booster will usually be installed at least half-way along the

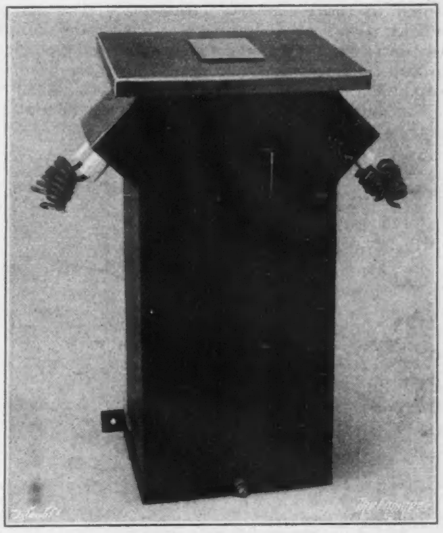


Fig. 8—"Apex" Regulator

distributor, the maximum load on the latter will be at least twice the rating of the booster, so that a 25-kVA booster will deal with a 50-kVA distributor. Standard single-phase, two-wire boosters are made for 10-kVA, 15-kVA and 25-kVA and single-phase three-wire and three-phase four-wire boosters for 25 kVA, but boosters for other kVA ratings and ranges of boosts other than 3 and 6 per cent. are also made. As in all cases the tap-changing switches are on the primary side of the transformer they only handle very small currents.

THE "APEX" REGULATOR.

A simple regulator which is being used with success on lines with approximately unity power factor is made by the Foster Engineering Company, Ltd., of Apex Works, South Wimbledon. Like other current-controlled regulators, it will give with constant supply pressure an increase of voltage with increase of load, or, alternatively, a steady secondary voltage. The regulator can be applied to the windings of a double-wound transformer, but is also made in the form of an auto-transformer booster, the amount of boost being determined within the limits of the apparatus by the amount and nature of the load connected to the secondary terminals. There are no moving parts, and the apparatus is therefore simple. Any desired ratio between the primary and secondary no-load pressures can be arranged for in the ordinary way.

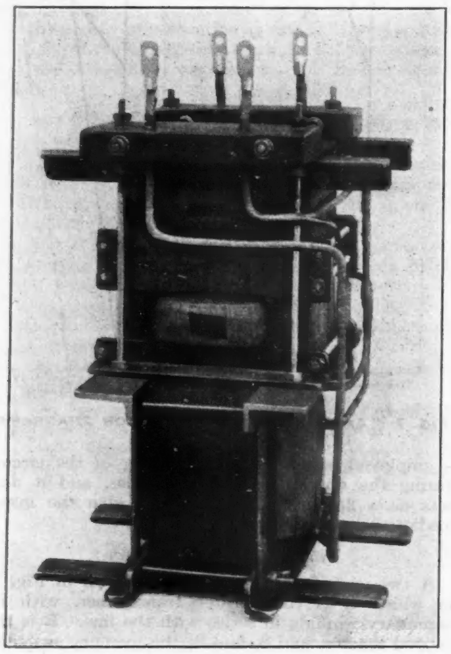


FIG. 9—"APEX" REGULATOR REMOVED FROM CASE

The auto and double-wound arrangements are shown in Figs. 5 and 6 respectively. It will be seen that in each case the transformer winding is tapped and the winding is designed to give a maximum voltage in excess of that required in the secondary circuit. Two reactances A B are connected to the secondary, as shown, and the tapping point at the centre forms one of the secondary terminals. Under no-load conditions, these reactances act as a potential divider, which is arranged to ensure that the desired secondary pressure is obtained at the outgoing terminals. The reactance A has a closed iron circuit, and is designed to work with a magnetic induction that prevents its terminal voltage greatly increasing when the load current passes through its winding. The other reactance B, however, has an air gap, so that under load there is a considerable increase in the voltage across it, and it carries a much smaller proportion of the load current. When a load of approximately unit power factor is connected to the secondary terminals the main secondary circuit may be considered to consist of the closed core inductance in series with the load resistance. Thus there is a considerable angle between the vectors of load and inductance volts, and these two vectors, together with that representing the transformer secondary volts, form a triangle. The inductance vector swings outwards from the no-load position (as shown in Fig. 7), but, by reason of the design of A, its length does not greatly increase, although the inductance is now carrying a much heavier current. The pressure applied to the second inductance has increased considerably, but, owing to its design, the current in this inductance only rises proportionally to the increase in volts at its terminals.

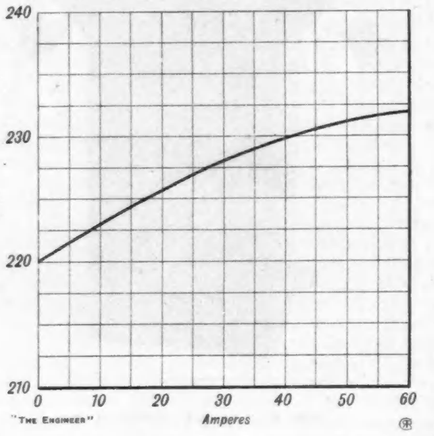


FIG. 10—"APEX" REGULATOR PERFORMANCE CURVE

Owing to the proportioning of the two inductances, the secondary pressure on load is greater than that at no load, but this only applies if the load has unity power factor. With a purely inductive load, there would be a drop in voltage, for in this case there would be two inductances in series across the transformer secondary, and their voltage vectors would be more or less in line with one another. Thus, as the load power factor decreases below unity, the boosting effect of the regulator diminishes. Moreover, as the vector diagrams, Fig. 7, show, there is a small phase angle between the primary and secondary volts, and although this is not sufficiently great to affect the power factor of the supply seriously, a circuit provided with one of these regulators cannot be paralleled with another circuit without a similar regulator. The apparatus may, however, be employed for maintaining the pressure on single supply circuits, such as a dead-ended "Tee off" from a ring main or on any other distributor not interconnected with other parts of the system, or for individual services from a distributor. Provided the load is non-inductive, the useful range of the regulator is at present up to 7½ per cent. increase in pressure from no load to full load, and the maximum boost can be arranged for any desired value within this range. The regulators are also supplied for use on high-tension mains. Fig. 8 shows one of these "Apex" regulators complete; Fig. 9 the regulator removed from its case, and Fig. 10 a characteristic curve based on a test in which the primary pressure was maintained constant at 220 volts, while the current was increased from 0 to 60 ampères. In considering the possibilities of this regulator, it should be remembered that, like Ferranti tail-end boosters, its action depends on the current passing through it, and it will not deal with bulk supply variations. It is, however, made for single or polyphase circuits, and can be used under the conditions mentioned on three-wire single-phase, four-wire three-phase, or any other ordinary A.C. distribution system.

(To be continued.)

Manufacture of Glucose.

By A. E. WILLIAMS, F.C.S.

ALTHOUGH more than a century has passed since the discovery by Kirschoff that a sweet syrupy liquid could be produced by the action of sulphuric acid on starch, very little progress had been made in the methods of manufacturing such a product until the post-war period. The large number of processes patented during the past ten years bears testimony to the interest which is now being taken in this branch of industry. Whilst the fact that pure crystal sugar is now prepared on a large scale from what was formerly waste vegetable matter is evidence of the remarkable advance resulting from the application of engineering and chemical science to the industry. In this article the object is to give a brief account of the present-day methods of glucose making, with special reference to the principal plant and machinery used therein.

Any material containing substance of the general formula $(C_6H_{10}O_5)n$ is a potential source of glucose. This material is present in the form of either starch or cellulose in nearly all vegetable matter. The various cereal grains, for example, all contain a large proportion of starch, whilst wood is rich in cellulose. What is at present a less important raw material for glucose making is found in the form of glucosides, substances of very complex formulæ, which are also present in most vegetable matter. The value of *n* in the formula for starch $(C_6H_{10}O_5)n$ is at present unknown. Some investigators have the opinion that it has a value of about 30; others place the number as high as 100. However, by the use of empirical formulæ the hydrolytic change by which the starch molecule combines with water to form sugar, under the influence of an acid catalyst, may be expressed in two stages, as follows:—

$$\underset{\text{Starch}}{2\,(C_6H_{10}O_5)} + \underset{\text{Water}}{H_2O} = \underset{\text{Maltose}}{C_{12}H_{22}O_{11}}$$

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + \underset{\text{Water}}{H_2O} = \underset{\text{Dextrose (glucose).}}{2\,(C_6H_{12}O_6)}$$

Prior to the formation of the intermediate sugar maltose, other dextrinous products are produced, as shown in the following table, which depicts the chief substances in the order of their formation during the action of an acid on starch.

TABLE I.

Product.	Formula.	Trade name.
Soluble starch	$2\,(C_6H_{10}O_5)$	Soluble starch
Amylo-dextrins	"	
Erythro-dextrins ..	"	Commercial dextrin
Achroo-dextrins	"	Liquid glucose
Maltose	$C_{12}H_{22}O_{11}$	Solid glucose
Dextrose	$2\,(C_6H_{12}O_6)$	Crystal glucose

When the raw material for glucose making consists of wood pulp, sawdust, or other waste vegetable matter, it generally receives a preliminary treatment to convert the cellulosic or starchy material partly into dextrinous substances, and so facilitate its subsequent conversion into glucose. This preliminary treatment often consists of warming up the raw material and then mixing in a small quantity of very weak hydrochloric acid solution, the material being afterwards spread out in thin layers to dry.

Another method of treating sawdust, &c., is to agitate it thoroughly in a vessel equipped with an efficient stirring apparatus, while a stream of dry hydrogen chloride gas is blown through the mass. The gas has the effect of breaking down the cellulose to a material of lower molecular weight, which is thus more easily converted to glucose.

In the production of glucose on a commercial scale the processes may be divided into definite stages as follows:—

(1) Conversion of the raw material into a weak sugar liquor.
(2) Neutralisation of the acid catalyst.
(3) Decolorisation of the sugar liquor.
(4) Concentration of the liquor.
(5) Crystallisation of the liquor.

CONVERSION PROCESS.

The hydrolysis, or conversion of the raw material into sugar, is effected in an autoclave or converter, which is essentially a pressure vessel constructed of suitable material to withstand the action of the acid catalyst used. For low acid concentrations, which are used in the conversion of starch to glucose the converter may be constructed of copper; a vessel of steel, homogeneously lined with lead, being usually more suitable for higher concentrations of acid, which must necessarily be used when the raw material is other than starch. Fig. 1 depicts a glucose converter constructed in copper by Blairs, Limited, of Glasgow. This vessel is 5ft. in diameter by 7ft. in depth, having a copper body ½in. thick riveted to the main body at the circumferential seam. The vertical seam on the body is also riveted. The vessel is fitted

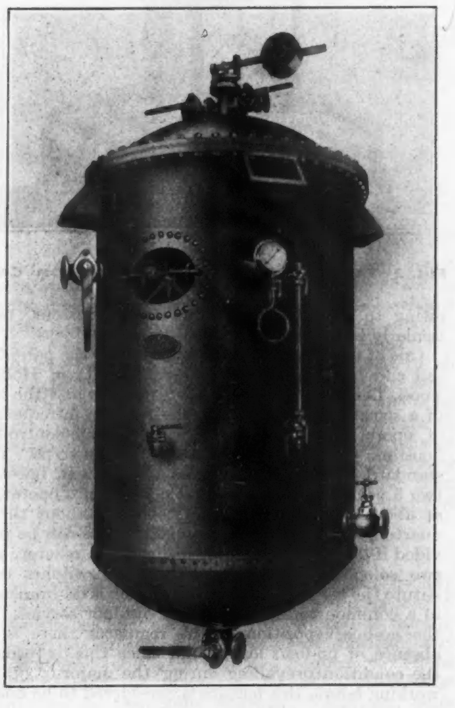


FIG. 1—GLUCOSE CONVERTER

with a copper dished dome, flanged to suit the body, and the main joint is complete with machined mild steel reinforcing jointing rings. Inside the converter is a steam coil of copper perforated to allow steam to be blown into the raw material and supported by the necessary stay supports. Outer fittings consist of a manhole with a heavy cover and a seat riveted to the bottom; inlet and outlet connections for the glucose material; steam stop valve; safety valve and air cock; pressure gauge and syphon; water and acid inlet cocks; and a sampling cock. The whole is carried on four heavy cast iron brackets fitted to the main flange. Such a converter is designed for working pressures up to 50 lb. per square inch.

Sulphuric acid was formerly in general use as a catalytic agent, being afterwards neutralised with powdered limestone, thus producing the insoluble calcium sulphate or gypsum, which was practically all removed by filtration of the liquor. The last traces of gypsum, however, were always difficult to remove, and this led to the formation of gypsum encrustations on the evaporator tubes during the concentration of the liquor, so lowering the efficiency of the evaporator appreciably. In modern practice hydrochloric acid is substituted for sulphuric acid and neutralised with soda ash, the resulting product being common salt, which is perfectly soluble in the liquor and is allowed to remain.

The raw material in admixture with a copious supply of water is first run into the converter and the necessary amount of acid catalyst is added. Steam at the required pressure is then blown into the mixture, and for a few minutes is allowed to blow through the vessel to atmosphere. The outlet valve at the top of the vessel is then closed, thus causing the pressure inside the converter to rise gradually until it equilibrates that in the steam supply line. By simple chemical tests on samples of the mixture drawn at intervals from a small cock in the base of the converter the progress of the hydrolysis may be ascertained. The total time occupied in converting the material to sugar is usually under one hour. It is not always the object to convert the whole of the batch into dextrose itself. From a glance at Table I. it will be seen that the grades known as liquid glucose and solid glucose respectively also contain some dextrin and maltose. So that in the production of these grades a complete conversion of the raw material to dextrose is not necessary. Only when crystal dextrose is to be produced is it essential to effect the conversion as completely as possible, so that the minimum of dextrin and maltose shall be present to interfere with the crystallising of the liquor. In practice it is not possible to produce a final product containing 100 per cent. dextrose, for before this desirable state can be achieved some of the dextrose first produced begins to decompose or revert.

The maximum proportion of dextrose sugars obtainable from a good quality starch depends on the steam pressure in the converter and the percentage of acid used. Modern practice is to use the minimum amount of acid and to increase the pressure accordingly, thus curtailing appreciably the length of time required for conversion and ensuring a lighter coloured liquor. The effect of pressure on the velocity of hydrolysis of starch to sugar may be noted by reference to Table II., the data for which was compiled from a series of experiments carried out in a small semi-commercial autoclave. Throughout this series of tests a definite proportion of acid, 0·4 per cent., was used.

TABLE II.

Batch No. ..	1	2	3	4
Temperature C.	122	135	142	148
Pressure in lb...	15	30	40	50
Duration of treatment ..	Per cent. conversion	Per cent. conversion	Per cent. conversion	Per cent. conversion
15 minutes ..	16	31	36	43
20 minutes ..	26	47	52	60
25 minutes ..	35	58	65	72
30 minutes ..	42	67	72	81
35 minutes ..	50	75	78	86
40 minutes ..	57	83	84	90*
45 minutes ..	61	91	92	90
50 minutes ..	62	96	96	90

* Point of maximum dextrose content.

From Table II. it will be clear that the most economical pressure when using 0·4 per cent. of catalyst would be 30 lb.; no advantage being gained by employing 40 lb. Whilst 50 lb. pressure is definitely disadvantageous, as reversion products are formed after 90 per cent. conversion, and very probably at an earlier stage, the loss due to reversion being counterbalanced for a time by the further conversion of dextrin. Apparently when the percentage of reversion products has attained a definite figure under these conditions of hydrolysis, any further formation of dextrose is inhibited. At 50 lb. pressure the maximum content of dextrose which can be produced under these conditions has been formed after 40 minutes' treatment; thereafter, the glucose content gradually diminishes, whilst the proportion of reversion products is enhanced. Although in the initial stages the velocity of hydrolysis is slightly accelerated for the higher pressures, the reaction is retarded as the proportion of sugars increases. Subsequent experiments have shown that by increasing the percentage of acid catalyst to 0·8 per cent. a similar reversion of sugar is experienced at lower pressures, *i.e.*, 35 lb. to 40 lb., and by decreasing the percentage of acid to 0·2 per cent. the economic working pressure would be raised to about 50 lb. It would appear therefore that for efficient and economic working the amount of acid catalyst to be used varies inversely with the pressure employed, within a limited range of pressure and percentage acid content.

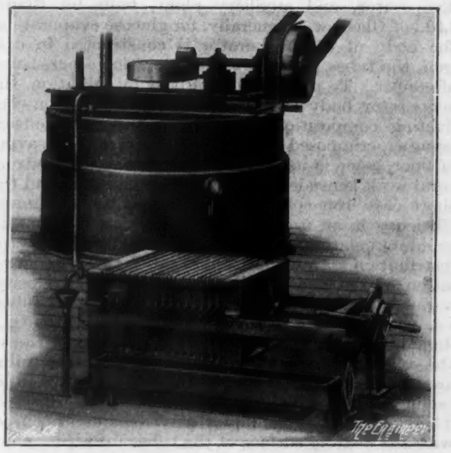


FIG. 2—DECOLORISING APPARATUS

NEUTRALISATION.

Two methods are in use for transferring the weak sugar liquor from the converter to a vessel wherein the acid catalyst is neutralised. One consists of first releasing the pressure in the converter and then pumping the liquor, with a direct coupled rotary pump, into the neutralisation vessel. In this method a considerable fall in temperature occurs in the converter immediately the pressure is released, so that cooling of the liquor is not usually necessary before neutralisation. The other method consists of utilising the pressure in the converter for forcing the liquor—*vid* a tubular cooler of 1½in. copper tubes, around which cold water circulates—into the neutralising vessel. In this case no pump is used, but a cooler is necessary as no temperature reduction occurs in the converter.

Generally, a copper cylindrical vessel with a conical bottom and efficient stirring equipment is used for the neutralising of the liquor. This is accomplished by gradually adding, to avoid excessive foaming, soda ash, which converts the hydrochloric acid into harmless common salt. For two reasons a slight trace of acidity is allowed to remain in the liquor. In the first place, a faintly acid liquor is more easily decolorised; secondly, a perfectly neutral liquor will rapidly foul the tubes of the evaporator during the concentration of the liquor, but a trace of acidity tends to keep the tubes clear of adhering sugar.

DECOLORISATION.

Until quite recently the removal of colour from the sugar liquor was accomplished by allowing the latter to percolate through a deep bed of charcoal, the emerging liquor being passed by a rotary pump to the top of the layer again for re-percolation; this process being continued until the liquor was sufficiently light in colour. With the advent of activated carbon—a material of very efficient decolorising capacity—another type of decolorising plant has been adopted. The advantages of this improved method of removing the colour from the liquor are that the process of decolorisation is speeded up, the loss of sugar liquor by absorption in the carbon is infinitesimal, and no revivification of the decolorant is necessary. In this method the glucose liquor is pumped from the neutralising vessel into the mixing tank seen to the rear of Fig. 2. The stirrer is then set in motion and about ½ per cent. (by weight) of activated carbon is added. This mixture is thoroughly stirred for one hour or so; then the whole is pumped through a filter press, seen in the foreground of Fig. 2, the carbon being retained by the press whilst the clear liquor passes out through the taps at the side of the press. The glucose decoloriser illustrated is built by Rose, Downs and Thompson, Ltd., Hull, and consists

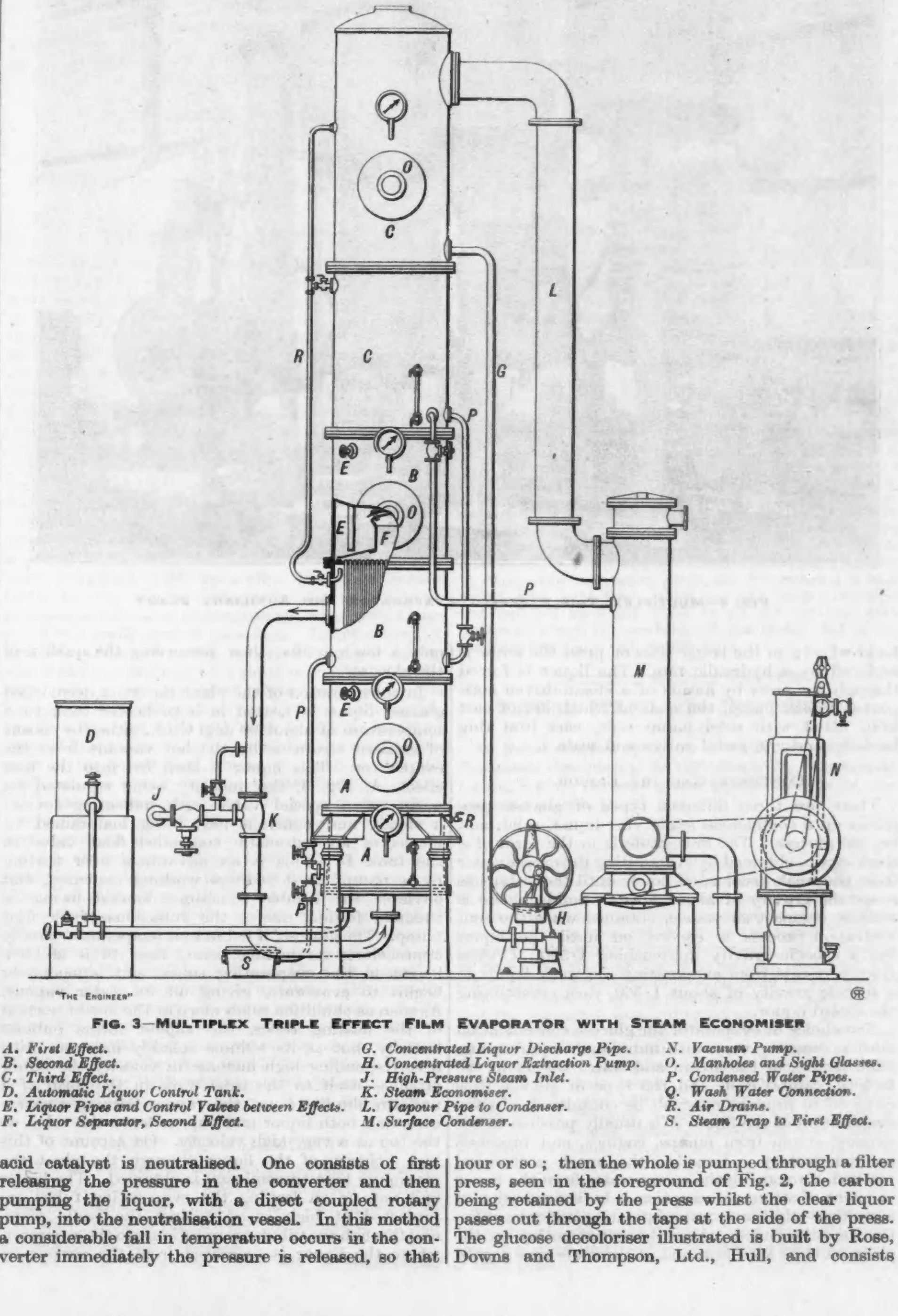


FIG. 3—MULTIPLEX TRIPLE EFFECT FILM EVAPORATOR WITH STEAM ECONOMISER

A. First Effect.
B. Second Effect.
C. Third Effect.
D. Automatic Liquor Control Tank.
E. Liquor Pipes and Control Valves between Effects.
F. Liquor Separator, Second Effect.
G. Concentrated Liquor Discharge Pipe.
H. Concentrated Liquor Extraction Pump.
J. High-Pressure Steam Inlet.
K. Steam Economiser.
L. Vapour Pipe to Condenser.
M. Surface Condenser.
N. Vacuum Pump.
O. Manholes and Sight Glasses.
P. Condensed Water Pipes.
Q. Wash Water Connection.
R. Air Drains.
S. Steam Trap to First Effect.

essentially of an open top bleaching vessel, so designed as to ensure a very intimate mixing of glucose and carbon. The pan is constructed of mild steel plates, and fitted with agitating gear operated by a belt through bevel wheels from the horizontal shaft. Paddle type agitators are fitted to the vertical shaft, which is carried in a footstep bracket specially arranged so as to keep the glucose outlet clear. The pan is arranged with an outside steam jacket, and also with a dry coil and the necessary supports. A gland cock is provided for the liquor outlet and the steam jacket is fitted with safety valve, air relief valve, steam gauge, and steam trap. Generally, the filter press is of the flush plate and distance frame type, the plates and frames being of cast iron. The glucose enters by a totally enclosed passage formed in lugs external to the filter cloth joints, and thus the cloths need not be cut for the admission of the liquor to the press. Similarly, the filtrate outlet is made in cuffs on external lugs. Cocks for first-running liquors—which are usually contaminated with carbon and so have to be passed back to the mixing pan—are provided at the bottom of each plate, these being used on starting the press and then closed, thus ensuring that no air contamination of the glucose is possible. A main drain and air cock are provided to allow of rapidly draining the press on completion of the batch. The side bars holding the plates and frames of the press are of mild steel fitted into the cast iron head and foot stocks; whilst the main closing screw is made of mild steel with a buttress thread. This screw may be operated by bar, ratchet gear, or geared hand wheel; in the larger sizes of press the screw is replaced by a hydraulic ram. The liquor is forced through the press by means of a steam-driven horizontal duplex pump, the ends of which are of cast iron, fitted with steel pump rods, cast iron ring buckets, and gun-metal valves and seats.

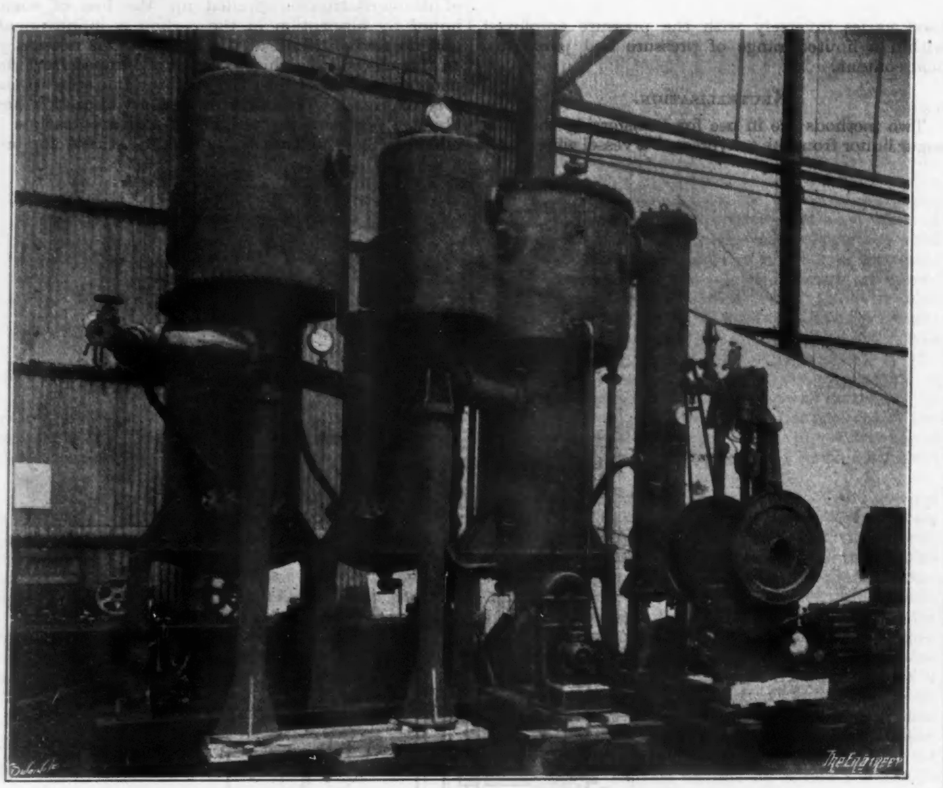


FIG. 4—MULTIPLEX TRIPLE EFFECT EVAPORATOR AND AUXILIARY PLANT

CONCENTRATING THE LIQUOR.

There are three different types of glucose produced on a commercial scale, viz., liquid, solid, and crystal glucose. The first grade is in the form of a thick syrup, obtained by evaporating the excess water from the weak decolorised liquor until the latter has a specific gravity of about 1·410. Solid glucose is a dense compact substance, obtained when the concentration process is carried on until the liquor has a specific gravity approaching 1·500. Crystal glucose results from evaporating the weak liquor to a specific gravity of about 1·360, then crystallising the cooled liquor.

The choice of evaporator for glucose concentration must necessarily vary with individual requirements. Such factors as the steam and water supply in the factory, capital cost, and the type of glucose it is required to produce must all be considered. In the evaporation of the liquor it is usually possible to use exhaust steam from pumps, engines, and processes in the factory. Usually, the most economical method of removing the excess water from the liquor in terms of steam consumption is by the adoption of a multiple effect evaporator operating under vacuum. On the other hand, where the initial outlay on the plant must be kept low, and at the same time a good supply of live steam is available in the factory, a single and double-effect non-vacuum evaporator is suitable. In both types of plant it is often advantageous to fix a steam economiser on the evaporator, which effects a great saving of steam by compressing part of the exhaust vapours from the liquor and returning it to the evaporator. Fig. 3 illustrates the general lay-out of a Multiplex Triple-effect Film Evaporator, and auxiliary plant, built by Blairs, Ltd., of Glasgow. Generally, for glucose evaporation, the body of the evaporator is constructed in cast iron, the tubes in which the evaporation occurs being of copper. To prevent loss of heat by radiation, the evaporator body is efficiently lagged with non-conducting composition. Owing to the three effects being superimposed one above the other, a great saving of floor space is made, and no elaborate steel structural work is needed to support the plant beyond the short cast iron columns. To obtain the maximum efficiency in an evaporator, it is necessary to ensure rapid circulation of the liquor and uniform heat distribution. It will be appreciated that the circulation of the liquor, and consequently the velocity, varies with the proportions of the evaporating tubes, *i.e.*, with the ratio of the heating surface of the tube divided by the cross section—or carrying area—of the tube. In the Multiplex evaporator the tubes are of such a precise diameter and length that rapid boiling with consequent circulation is ensured. Therefore the glucose liquor only remains in contact with the heating surface of the tubes for a very short time, its entire passage through the plant occupying only a few minutes, thus preserving the quality of the glucose.

In the operation of the plant the weak decolorised glucose liquor is heated in a preheater tank to a temperature of about 90 deg. Cent., either by means of exhaust steam or by the hot vapours from the evaporator. This liquor is then fed into the first effect, A, Fig. 3, the quantity being regulated by means of a special valve with indicating device; a steady and constant feed being maintained by means of an automatic controlled float valve in the tank D. This is an advantage over feeding by a pump, as it reduces working expenses, and obviates the trouble sometimes caused owing to irregular feeding due to the pulsations of the feed pump. The glucose, if fed in at a temperature closely approaching its boiling point, rises to a uniform height in the evaporating tubes, and immediately begins to evaporate, giving off its water vapour. As soon as ebullition takes place at the lowest portion of the heating tubes, the vapour forms bubbles initially, but as its volume steadily increases with a corresponding high increase in velocity the liquor attaches itself to the tube walls in the form of a uniform film-like layer, the vapour forming a centre core, and both liquor and vapour leave the tubes at the top at a very high velocity. On account of this high velocity of the liquor through the plant the maximum heat transmission is obtained. The liquor and vapour on leaving the evaporating tubes are projected at high speed against the baffle plate, and through the tubular connection into the separator, where the liquor is separated from the vapour by means of the specially devised foam separator which ensures perfect separation and freedom from entrainment. The liquor is carried down on to the baffle plate, and is then drawn up owing to the reduced pressure into the second effect, through the internal liquor pipe, and into the liquor chamber of the second effect. The vapour passes into the heating chamber of the next effect through the central intake, thus ensuring equal distribution in the vessel, so that all the heating surface is heated with the utmost uniformity, resulting in high efficiency. The concentrated liquor—at the required density—is removed from the last effect by means of a pump; but where conditions are suitable, this can be dispensed with, the liquor being discharged continuously under a barometric head. The condensed steam from the first chamber can be used for boiler feeding, or passed on into the second effect, where, on account of the low pressure in the chamber, it vaporises, and the heat it contains does further useful work. The condensed steam from the second effect is taken into the heating chamber of the third effect, where it also gives up some of its heat. All the vapour from the last effect is taken through the condenser, and the condensed steam from the heating chamber is either withdrawn through the condenser, or by means of a separate pump.

Fig. 4 shows another type of Multiplex Triple-Effect evaporator with auxiliary plant assembled in the workshops of Blairs, Ltd. In this plant the three effects are placed side by side, instead of being one above the other. A special feature of the plant is the introduction of a side separator into which the mixed liquor and vapour is passed immediately after leaving the top of the evaporating tubes, which permits of a very short "top header," with a hinged or other type of cover which is readily removable. On this being opened, and the bottom cover swung down on its hinges, the whole of the liquor side of the evaporator is exposed for examination or cleaning and the tubes can be brushed or scraped out immediately after the cessation of work, whilst the cleaners remain always in the open air. These advantages will readily be appreciated by all engineers who have had to deal with the ordinary type of vertical evaporator, for which several hours have usually to be allowed for cooling down, and even after that the cleaners have to enter the vessel by climbing through small manholes at the sides, and have then to work inside closed vessels which are still much too hot for comfort and for efficient working.

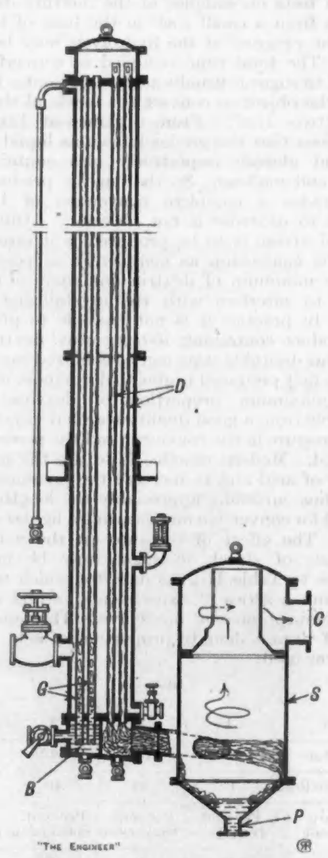


FIG. 5—KESTNER PATENTED FALLING FILM EVAPORATOR

B. Liquor Inlet Box.
G. Climbing Film Tubes.
D. Falling Film Tubes.
S. Separator.
C. Vapour Outlet.
P. Concentrated Liquor Outlet.

Another type of evaporator much used in the glucose industry is the Kestner Falling Film evaporator, made by Kestner Evaporator and Engineering Company, Ltd., London, and illustrated in Fig. 5. In this plant the weak glucose liquor enters at B and then passes into a series of 2in. copper tubes surrounded by steam; a climbing action immediately commences, the vapour from the heated liquor forming a core in the centre of the tubes, and carrying up a thin film of liquid round the inner surface of the tubes. When the vapour and liquor arrive in the upper box above the tube plate, they pass to the down tubes, the liquor passing down as a film, and the vapour forming a core in the centre of the tubes. The liquor and vapour now pass to the separator, where, by centrifugal action, the vapour passes through the upper outlet C to the condenser, and the liquor through the lower outlet P. This evaporator will remove when necessary from 70 to 80 per cent. of water from the glucose liquor in one passage through the plant.

Under certain conditions it is possible to effect a great economy in the evaporation of the glucose liquor by the utilisation of waste steam from the evaporator and other steam using processes in the factory, by compressing the vapours and thus increasing the heat available. Usually, a mechanical compressor is not so economical as the steam-jet type for this purpose, as the former requires a greater motive power to operate it. Fig. 6 illustrates a Kestner Falling Film evaporator fitted with an injector-compressor, in which A is the compressor; B, steam drier; C, evaporator; D, separator; E, feed pump; F, weak liquor inlet; G, high-pressure steam main; H, live steam inlet to compressor; I, waste vapour outlet; J, vapour suction pipe leading to compressor; K, pipe carrying mixture of live and exhaust steam; L, weak liquor inlet to feed pump; and M, wash-water inlet. A supplementary live steam pipe is provided for use when working without the injector-compressor, and the waste vapour then passes to atmosphere through the exhaust main I, which is throttled when the compressor is working. It will be obvious that the higher the pressure required in the mixed steam in K, the greater the proportion of live steam that must be used, and, therefore, the less the saving which can be effected through the compressor. For instance, assuming the waste vapour to be at atmospheric pressure, and the live steam at 100 lb. gauge pressure, the proportion of waste vapour in the mixture, and, therefore, the saving of live steam effected, will be:

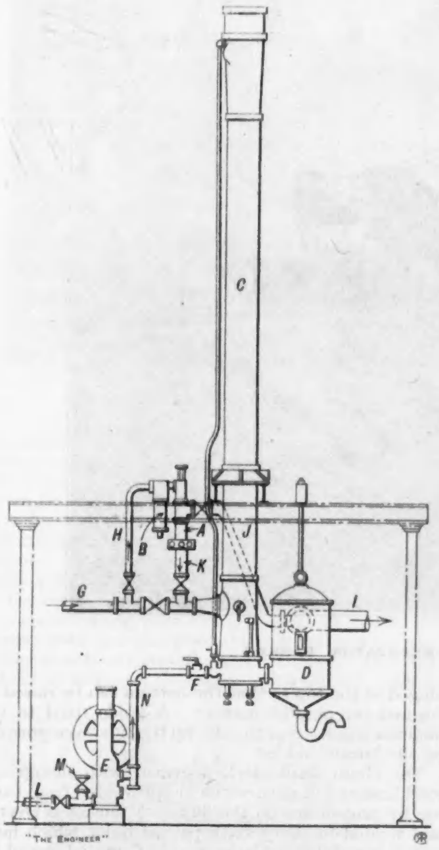


FIG. 6—KESTNER SINGLE EFFECT WITH INJECTION COMPRESSOR

A. Kestner Injection Compressor.
B. Kestner Steam Dryer.
C. Kestner Evaporator.
D. Kestner Separator.
E. Feed Pump.
F. Kestner Liquor Regulator.
G. Main Steam Inlet.
H. Auxiliary Steam Inlet to Injector Compressor.
I. Vapour to Atmosphere.
J. Auxiliary Vapour to Injector Compressor.
K. Mixed Steam to Evaporator
L. Liquor Inlet Valve Suction
M. Wash Water Valve Suction
N. Liquor to Evaporator.

	Per cent.
For mixed steam at 2 lb. pressure	64
For mixed steam at 5 lb. pressure	51
For mixed steam at 10 lb. pressure	29
For mixed steam at 15 lb. pressure	24

These figures, which show a substantial saving of live steam, are based on actual works' experience and not on short test runs, which frequently show much higher rates of saving. An important point is that, under all circumstances, the mixed steam is delivered in a perfectly dry condition, even if the live steam is wet, owing to the superheating of the live steam due to the "wire-drawing" action of the injector-compressor. It must be remembered in this connection that exhaust steam or vapour, whether from engines or evaporators, is always "wet" or supersaturated, and that therefore a pound of such vapour which has not been passed through the compressor has not the same heating value, due to latent heat, that is possessed by a pound of "dry" steam at the same pressure.

CRYSTALLISATION PROCESS.

For the purposes of crystal glucose the liquor is concentrated in the evaporator until a specific gravity of about 1·360 is attained. This liquor is then run into crystallising pans, which may conveniently be circular steel vessels of about 8ft. diameter by 3ft. deep, and provided with a jacket through which either cold water or steam may be circulated as desired. The liquor is cooled to a temperature of about 36 deg. Cent. by circulating cold water in the jacket. To induce crystallisation in the cooled liquor it is advantageous to add a sprinkling of "seed" crystals from a previous batch of glucose. Around these seed crystals other crystals are gradually built up from the liquor until the whole of the mass is in a semi-solid crystalline state. This is then transferred to a centrifugal machine which separates the crystals from the remaining liquor. The latter is generally sold as liquid glucose. From the centrifuge the crystals pass into a vacuum band dryer in which they are dried by being passed slowly, on endless belts, between steam-heated chambers.

Glucose is used largely in the confectionery, jam, and fruit-jelly trades, and especially in the manufacture of sweets and toffee, in which it is often the chief constituent. Large quantities are also used in the brewing industry. Other edible uses include the adulteration of honey, and the preparation of "caramel," obtained by heating glucose to about 200 deg. Cent. Caramel finds an outlet for the colouring of numerous edible liquids. Non-edible uses of glucose include the preparation of textile sizes, and adhesive pastes in general. Some idea of the increasing demand for crystal glucose may be gained from the fact that in the U.S.A. alone, the annual production of this type of sugar has increased in the last few years from 38,000 to over 400,000 tons.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE ENGINEER SALESMAN.

SIR,—Before the war it was beginning to be recognised that there was a very definite opening for trained engineers with a bent for the selling side, capable of following up inquiries and able to deal with both the sales and engineering problems that might arise. If my memory serves me well, THE ENGINEER was foremost in advocating such careers. The idea was that the men should be able to give an intelligent explanation to any point and to assist the prospective customer in any way that might be useful, both in furthering the sale and ensuring that the purchase would be successful at work.

Immediately after the war there was a considerable demand for such men, with the result that many first-class men took up the work, often very successfully, trade being then very different from its condition to-day. Firms of repute were willing to make a reasonable allowance towards out-of-pocket expenses. Some allowances were extravagant, which was a pity. It would have been better to keep expenses allowances low and be more generous in the matter of commissions, which would have suited the really earnest men best. Unfortunately, it attracted a class of person whose whole object was to collect as many expenses allowances as possible. Usually gifted with a very persuasive tongue (very useful in its right place), he could cajole an agency out of the principals of a firm, and then do as little work as possible in return. Pests of this type have done a great deal to ruin the prospects of the honest hard worker, so much so that the pendulum has swung in the opposite direction, and it has become increasingly difficult to get a representation carrying with it an allowance of any sort, even for the most reasonable amount.

Firms are only too willing to allow one to work on a purely commission basis, paying all one's own expenses. This, of course, is grossly unfair, because it means that the representative, if a good one, is building up a connection at his personal outlay for another firm. If he is successful, there is nothing to prevent his employer terminating the agency, and, if he wishes, taking up the work himself or passing it on to some favourite nominee. This actually happened to the writer. Would-be sales engineers should remember that if a firm is not willing to grant either a moderate allowance or a representation on a minimum commission basis, they have very little confidence in their own product, and on the whole are best left alone.

November 20th. SALES ENGINEER.

FRANCE AND MANCHUKUO.

SIR,—In connection with your leading article on Continental Industrial Plans and Monsieur Sarraut's ideas for international collaboration, it is interesting to note that France is taking very great pains to try and secure a footing in Manchukuo.

There is no doubt that there will be considerable developments in that territory, and it would appear that, although Japanese influence is paramount, the policy of the "open door" (more or less) will be followed, chiefly owing to the critical attention which is being shown by the whole world to see how far this profession of policy will be carried out.

Our French friends are certainly not backward in coming forward, and have had investigators on the spot for some time, representing powerful financial interests backed, it is said, by Government support.

From accounts of these activities, however, it would appear that there is little intention of carrying out Monsieur Sarraut's idea of international collaboration, in which case the competition among European—and American—manufacturers under conditions of monetary chaos, to which you refer, will continue, and be particularly severe for this potential market.

Incidentally, it is to be doubted whether British firms are taking the possibilities of developments in Manchukuo as seriously as they should; they have certainly so far not shown anything like the initiative and energy the French have, and the reason, one ventures to think, is a feeling that in spite of their protestations, the Japanese mean to see that although the front door may be open, the only one that will be of any use will be the side or tradesmen's entrance—and they will keep the key!

CHINA HAND.

London, E.C., November 17th.

SIXTY YEARS AGO.

IT is just over sixty years since horse-drawn tramways became established in this country. Naturally, it was not long before various designs of steam-propelled tramway cars were evolved. One such car, built in accordance with Grantham's patents, was illustrated in our issue of November 28th, 1873. We had attended trials of the vehicle two days previously on the tramway line "below Victoria Station and Vauxhall Bridge." The boilers and engines had been made by Merryweather's, but it would seem that the boilers failed to give a good account of themselves on the occasion of the trial. They could not "keep steam" properly, so we said, because they were too small for their work and possibly, also, because the crowded state of the car rendered their firing difficult. Our engravings show the car as a double-deck vehicle with a "knife board" seat on top, a central chimney, and a driving platform at each end. The vehicle was equipped with two sets of wheels, namely, four flanged wheels for running on rails, and four flangeless wheels which, when the others were raised by means of a steam cylinder, were intended to permit the car to run on an asphalt road. One pair of the flangeless wheels was mounted to turn about a central pivot for steering purposes. Two boilers of Field's patented type were mounted inside the body at the middle of its length, but they were enclosed in cupboards in order that no smell or heat might be transmitted to the interior of the car. They supplied steam to a single inclined cylinder slung underneath the lower floor. It is not clear how the cylinder transmitted its power to the wheels, or how the drive was transferred from the flanged to the flangeless wheels when the change was desired. Although the trial was not wholly successful, it afforded, we said, fair promise of better things in the future. The subject of steam tram locomotion was, we said, a large one, and we intimated our intention of dealing with it in an early issue . . . A note regarding improvements recently made in electric lighting by Mr. A. Ladiguin, of St. Petersburg, is of interest as foreshadowing in some way the modern gas-filled lamp. Hitherto, it was explained, one of the principal difficulties in the way of applying the magneto-electric machine for purposes of illumination resided in the want of steadiness induced by the rapid burning away of the two carbon points between which the arc was established. Mr. Ladiguin surmounted this difficulty by using only one carbon point, and by enclosing it in a sealed glass tube from which air had been exhausted and replaced by a gas which would not combine with carbon at a high temperature. It was stated that in use the lamp emitted a soft, steady light.

BRITISH STANDARDS INSTITUTION.

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LARCH POLES.

No. 513—1933. This specification has its origin in a request from the Forestry Commission that investigations should be made with a view to ascertaining whether home-grown larch was suitable for transmission poles. A large number of tests were carried out at the Forest Products Research Laboratory, Princes Risborough, and the results of these tests indicated that, with suitable treatment, the unfavourable characteristics of larch could be overcome.

In the Foreword to this Specification it is pointed out that the Committee was confronted with those unfavourable characteristics peculiar to larch which had militated against the use of poles of this species in the past, namely, the tendency for seasoning checks to become localised, rendering the pole unsafe for climbing with spurred climbing irons, and also the twisting that takes place at the top of the pole, occasioned by the presence of spiral grain. It was, however, considered now possible to control the former characteristic by suitable treatment, while the second, which is only of small account if the points of attachment of the conductor are close to the pole, can be eliminated by specification.

The specification includes tables of dimensions and deals fully with the methods of creosoting. In an Appendix are given some useful tables of ultimate breaking loads of larch poles.

The Public Works, Roads, and Transport Exhibition.

No. III.

(Concluded from page 503, November 17th.)

Hadfields, Ltd.

The main exhibit of Hadfields, Ltd., East Hecla Works, Sheffield, was the crushing and screening plant, typified by Fig. 35. which is capable of producing from 10 to 12 tons of road metal per hour. It is, it will be seen, a combination of a double-toggle crusher with two rotary screens and an elevator, so arranged on a wheeled underframe that the road metal is delivered sufficiently high to fall into carts alongside.

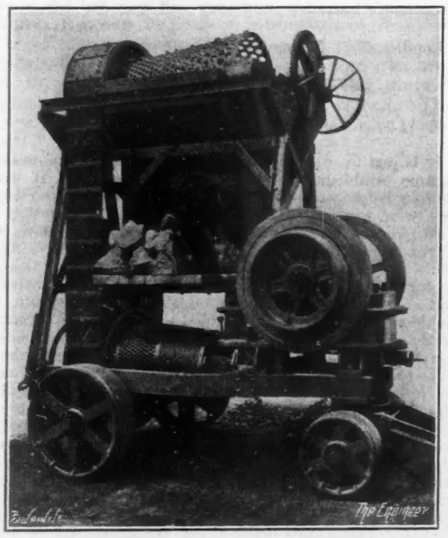


Fig. 35—Crushing and Screening Plant—Hadfields

The breaker has a jaw opening of 20in. by 10in., and is chiefly noteworthy on account of the fact that the frame is a single casting of the makers' toughened steel, which enables the weight to be reduced by 50 per cent., as compared with cast iron. The jaw stock and pitman are made of the same material, and the crushing faces of Era manganese steel. The latter are, of course, renewable. The crusher runs at 250 revolutions per minute, and requires about 25 horse-power. It delivers into the lower rotary screen, which has fine perforations for taking out small stuff that may be used for road surfacing. The oversize from this screen goes to the elevator, which is of the internal bucket type, and is raised to the top screen. It is there graded into two sizes and delivered into hoppers, from which it can be shot into carts. The oversize is returned to the breaker for further reduction. The total weight of the plant is about 252 cwt. Other exhibits on this stand included spare parts for crushers in manganese steel, non-corrodible steel road studs, and specimens of high-speed tool steel.

R. Broadbent and Son, Ltd.

There were two new machines on the stand of Robert Broadbent and Son, Ltd., Phœnix Iron Works, Stalybridge, one of which we illustrate in Fig. 36, while the other was a granulator for producing fine chippings. This latter machine is a jaw-breaker with a single toggle, but is characterised by the fact that an auxiliary lever and toggle transmit part of the thrust on the jaw stock back to the level of the excentric shaft, and thus relieve the rotating rubbing faces of some of the load. At the same time the movement of the jaw is such that the material being reduced is subjected to a rolling rather than a grinding action, and the production of fines is minimised.

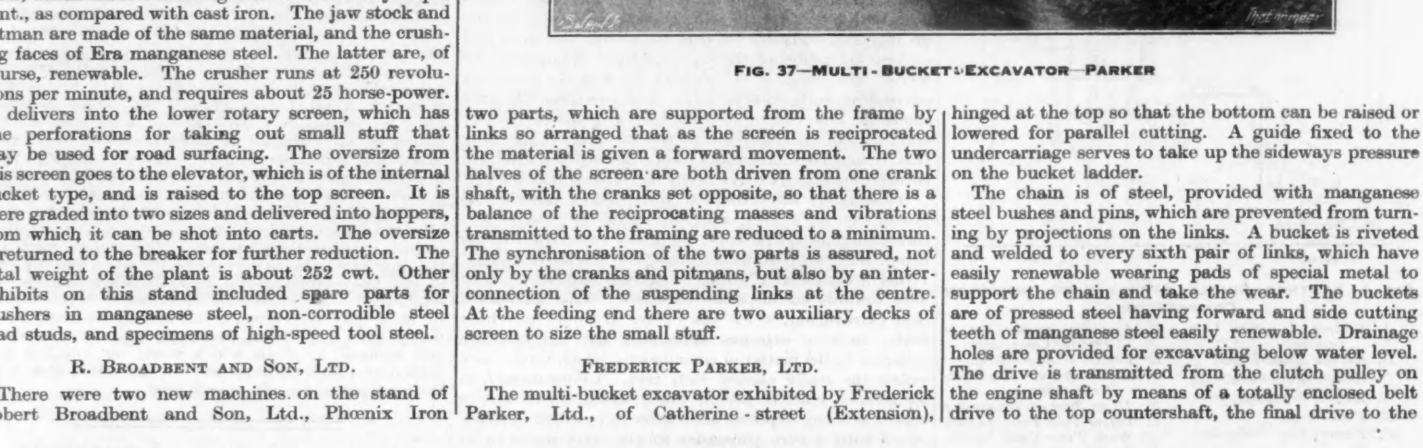


Fig. 36—Counterbalanced Shaking Screen—Broadbent

The shaking screen, which we illustrate, is put forward as an alternative to a rotary screen on the score that the screening plates are rectangular and flat, and consequently can be easily replaced as they wear away. The screening surface is divided into two parts, which are supported from the frame by links so arranged that as the screen is reciprocated the material is given a forward movement. The two halves of the screen are both driven from one crank shaft, with the cranks set opposite, so that there is a balance of the reciprocating masses and vibrations transmitted to the framing are reduced to a minimum. The synchronisation of the two parts is assured, not only by the cranks and pitmans, but also by an interconnection of the suspending links at the centre. At the feeding end there are two auxiliary decks of screen to size the small stuff.

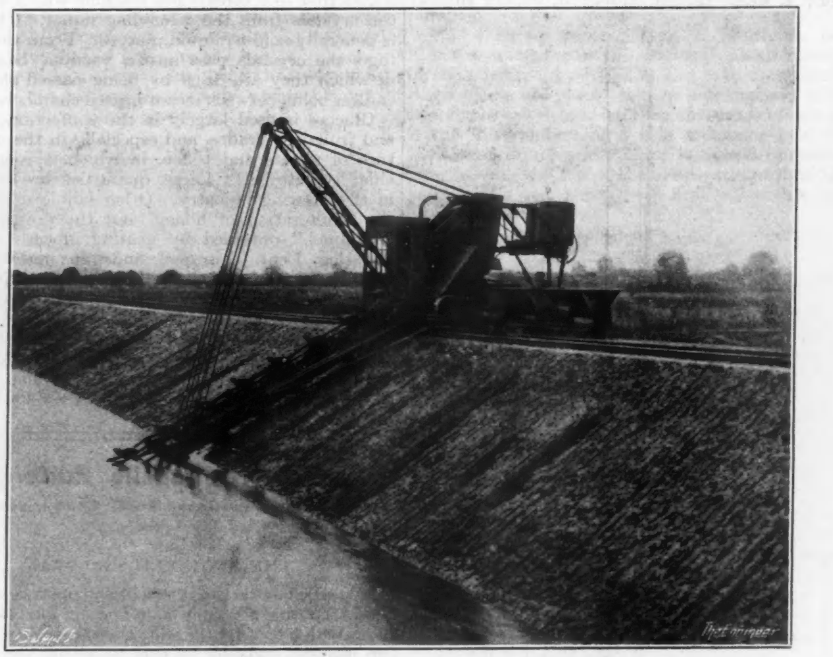


Fig. 37—Multi-Bucket Excavator—Parker

Frederick Parker, Ltd.

The multi-bucket excavator exhibited by Frederick Parker, Ltd., of Catherine-street (Extension), Leicester, and illustrated in Fig. 37, is not, of course, new in principle, as such machines have been used extensively on the Continent, but we believe that up to now few have been made in this country. It is what might be described as a land dredger, and comprises a bucket ladder supported from a carriage which also houses the oil engine. The ladder is a light but very strong lattice work, constructed of steel sections, gussetted and riveted together. Its length can be easily altered, and knuckle joints and a levelling extension can be added. The bottom angle sections of the framework act as guides to the chain, being fitted at the top, bottom and sides with easily renewable steel liners. On the top of the framework are rollers for the support of the chain, the spindles running in bearings, having blank ends to exclude grit. The idler rollers at the end of the bucket ladder are attached to a steel shaft, which has a renewable sleeve, running in gun-metal bushed adjustable bearings. Adjustment is by screws in manganese bronze nuts for taking up slack in the chain. A removable end cap to these bearings allows renewal of the bush and sleeve without dismantling other parts. Gun-metal bushed idler rollers, revolving on a fixed steel shaft, are provided at each end of the knuckle joint, and at the junction of the lower and upper bucket ladder. The upper bucket ladder is of similar construction to the lower portion, being hinged at the top so that the bottom can be raised or lowered for parallel cutting. A guide fixed to the undercarriage serves to take up the sideways pressure on the bucket ladder.

The chain is of steel, provided with manganese steel bushes and pins, which are prevented from turning by projections on the links. A bucket is riveted and welded to every sixth pair of links, which have easily renewable wearing pads of special metal to support the chain and take the wear. The buckets are of pressed steel having forward and side cutting teeth of manganese steel easily renewable. Drainage holes are provided for excavating below water level. The drive is transmitted from the clutch pulley on the engine shaft by means of a totally enclosed belt drive to the top countershaft, the final drive to the sprocket shaft being through spur reduction gears. The bucket chain runs on two hexagonal sprockets mounted on a large diameter shaft running in gun-metal bushed bearings. Each sprocket has reversible and easily renewable manganese steel teeth and a side guide flange. The buckets discharge through the back when passing over the top sprocket into a storage hopper of approximately half a cubic yard capacity, having a door which can be left open or closed at will. In certain cases a mechanical scraper is provided to aid discharge. The wagons for the material travel with the excavator, which connects with the side of the wagon by an arm. They are, of course, hauled away when filled.

A machine of this type with a 49ft. ladder, which will dig to a depth of 35ft. and have an output of about 100 cubic yards per hour, requires 36 horse-power. It runs on a track of 7ft. gauge, and weighs some 50 tons.

Atlas Diesel Company, Ltd.

The air compressor illustrated by Fig. 38 is a new one exhibited by the Atlas Diesel Company, Ltd., of New Oxford House, Hart-street, W.C.1. Its chief peculiarity lies in the fact that the engine and compressor are built as one unit with a single crank shaft. The engine is a four-cylinder two-stroke solid injection oil engine and the compressor single-acting, with two cylinders. But the lower side of the compressor pistons are used to supply the scavenging air for the engine. The design is very simple and the number of component parts is, naturally, reduced.

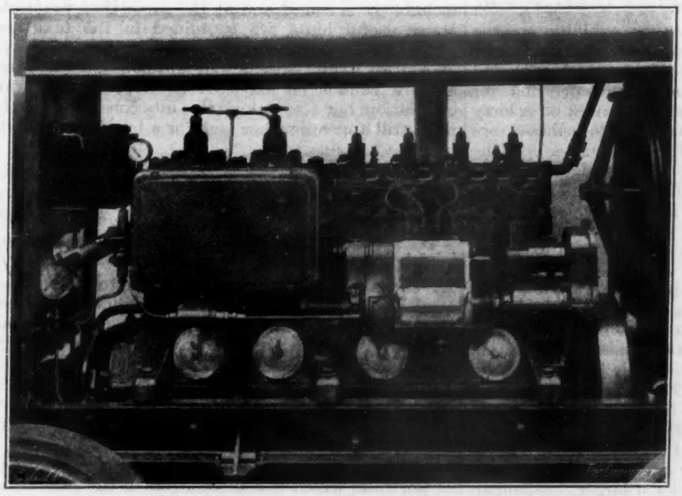


Fig. 38—Portable Air Compressor—Atlas

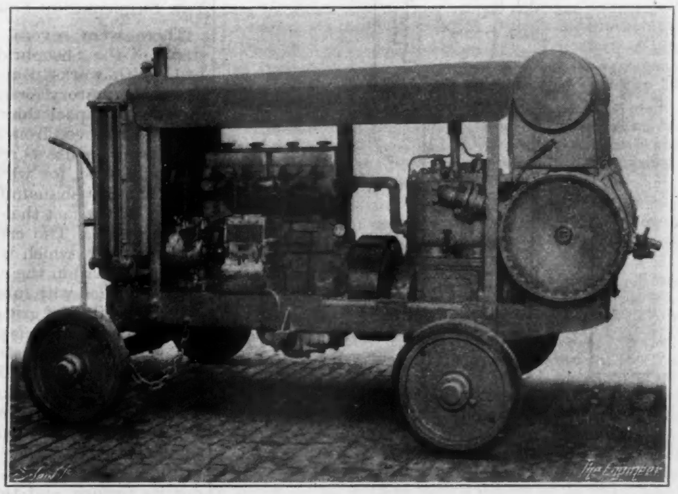


Fig. 41—Portable Air Compressor—Air Pumps

The set is fitted with forced lubrication throughout, and an automatic engine speed reduction gear so connected with the compressor unloader regulator as to follow closely all variations of the load. The small generator fitted to the engine automatically charges an accumulator for heating the starting device, and can also be used for lighting, which is a great convenience at night. Though fully enclosed, all parts are accessible for inspection; adjustments are few and simple, and the machine requires practically no attention when running. The compressor is designed for working up to 100 lb. per square inch pressure, and when running at its normal speed of 1000 r.p.m. has a piston displacement of 180 cubic feet per minute, with an indicated capacity of about 132 cubic feet free air per minute. The engine is rated for 30 B.H.P. continuously, and the fuel consumption of the set under ordinary working conditions is about 10 lb. of fuel oil per hour. The overall dimensions are approximately 8ft. 6½in. length by 4ft. 10½in. width by 5ft. 8in. height, and the net weight about 34 cwt., thus not differing appreciably from a petrol-driven machine of corresponding output.

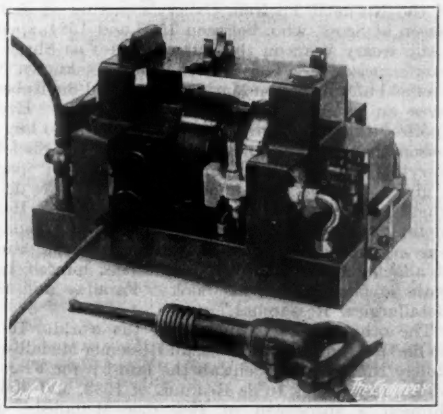


Fig. 39—Portable Electric Air Compressor—Atlas

The little air compressor shown in Fig. 39 is intended to be handled by two men. It comprises an air-cooled compressor direct coupled to an electric motor; mounted upon a rectangular air receiver, requiring a floor space of only about 2ft. by 1ft. 2in., and weighing complete only about 110 lb. It is designed for a maximum pressure of 50 lb. per square inch with a capacity of about 11½ cubic feet of free air per minute, sufficient for operating a light chipping or riveting hammer, or drill, &c., and thus could be found useful for building and erection work wherever a direct or alternating current supply was available. It is supplied with a switch, plug contact, 30ft. length of electric cable, and 50ft. length of ½in. air hose, while a light " Atlas " chipping hammer is usually included as equipment.

Air Pumps, Ltd.

There were four air compressing sets on the stand of Air Pumps, Ltd., Emerson-street, Southwark Bridge, London, S.E.1. Two were driven by heavy oil engines and two by petrol engines. We illustrate in Fig. 41 one of the former, driven by a Dorman-Ricardo engine. It has an air output of 147 cubic feet of free air per minute and a working pressure of 100 lb. per square inch. The air compressor has two cylinders, 6in. in diameter by 4½in. stroke, while the engine has four cylinders, 4in. by 5⅛in. The speed is 100 r.p.m. The air valves are spring loaded steel plates, hardened and ground all over. A larger set of the same general type, but with a capacity of 300 cubic feet per minute, was also exhibited on this stand. Another exhibit was a small air-cooled petrol-driven plant, useful for building construction, and other work where painting has to be done. It is a very compact unit, the overall dimensions being 37in. by 24in. by 37in., so that it can be transported anywhere in the building without difficulty. As both engine and compressor are air cooled, and as these sets generally work in places where low temperature exists in winter time, the user is relieved of all anxiety with regard to freezing up at night.

Petters, Ltd.

The most noteworthy exhibit on the stand of Petters, Ltd., Yeovil, was, perhaps, the new 5 and 8 H.P. Atomic Diesel engines, illustrated by Fig. 40, the constructions of which are almost identical, while they run at speeds of 750 and 650 revolutions per minute respectively. They are, it will be seen, of the vertical, single-cylinder type, and are intended for running on the lighter grades of fuel oil. The cylinder head is of very simple design, and has a detachable steel water jacket, which not only greatly facilitates cleaning of the water passages, but also tends to relieve internal stresses in the head. The combustion chamber is of the open type, the atomiser being arranged centrally in the head and completely surrounded by cooling water. Both the underside of the cylinder head and the piston crown are machined all over, thus offering the least possible resistance to scavenge air, and, at the same time, promoting good turbulence. A compression release valve is fitted for use when starting by hand, and it is worthy of note that no form of preheating device whatever is required for starting nor is a secondary combustion chamber used.

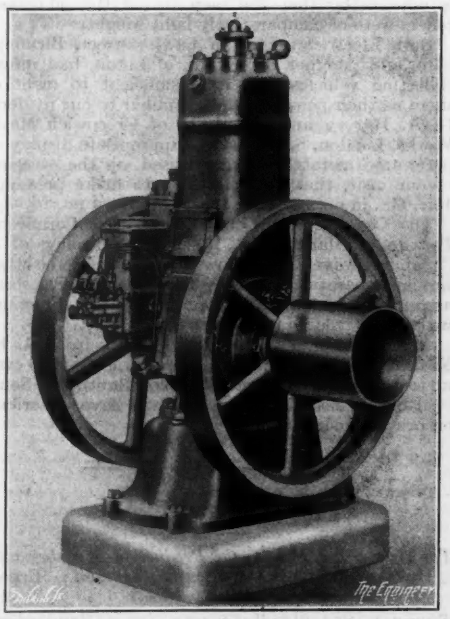


Fig. 40—5 B.H.P. "Atomic" Engine—Petters

There were on this stand some other oil engines of greater output, which have been improved by the use of ball and roller bearings, and an air-cooled engine of 4 horse-power. A contractor's set, comprising a pump capable of drawing 4000 gallons per hour against a suction head of 25ft., driven by a 2 H.P. air-cooled engine, and an air compressing set, capable of delivering 5¼ cubic feet of free air at a maximum pressure of 350 lb. per square inch, were also exhibited.

Bell Brothers (Manchester 1927), Ltd.

The stand of Bell Brothers (Manchester 1927), Ltd., of Calder Ironworks, Denton, Manchester, was devoted to the chlorination of water supplies for their sterilisation, and also their filtration. The filters were exemplified by scale models, while a chlorination plant, such as that illustrated by Fig. 42, was shown in full scale.

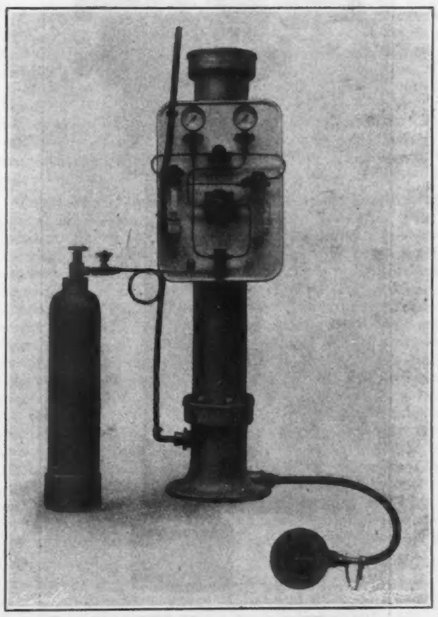


Fig. 42—Chlorination Plant—Bell

This chlorinating plant, which is also shown diagrammatically in Fig. 43, is intended for industrial services; that is to say, in those cases where a slight overdose of chlorine will not be objectionable on account of its taste, as it might be with potable water, but yet a thorough sterilisation is desired. For such purposes a gravity feed of an aqueous solution of chlorine, into the rising main, has been found most satisfactory, and the apparatus illustrated is used for this purpose.

Referring to the diagram, Fig. 43, which, it will be noticed, includes two bottles for storing the liquid chlorine, as against only one bottle in the half-tone engraving, Fig. 42. The chlorine gas evolved from the liquid in the bottles A A is controlled by the valves B B, and goes by flexible pipes to the combined junction-box and filter C, which is fitted with a pressure gauge D. The pressure of the gas is reduced by a reducing valve at E, equipped with another gauge F, to a pressure of about 1¼ lb. per square inch. Both the gauges are so arranged that their working parts are not subjected to the corrosive action of the chlorine gas. From the pressure reducer the gas is admitted through the micrometer valve G to the meter H. (An enlarged view of this meter is given in Fig. 44, while its operation is described later.) The meter gives a direct reading of the amount of chlorine passing, which can be regulated by the valve G. The gas then goes through the valve J to the absorption chamber K. This chamber is made of glazed, acid-resisting stoneware, and is supplied with a trickle of water that absorbs the chlorine. The resultant solution flows away by the pipe L to the supply which is to be sterilised. A drying apparatus is provided at M in order to inhibit the passage of any moisture from the absorption chamber to the control apparatus when the flow of gas ceases.

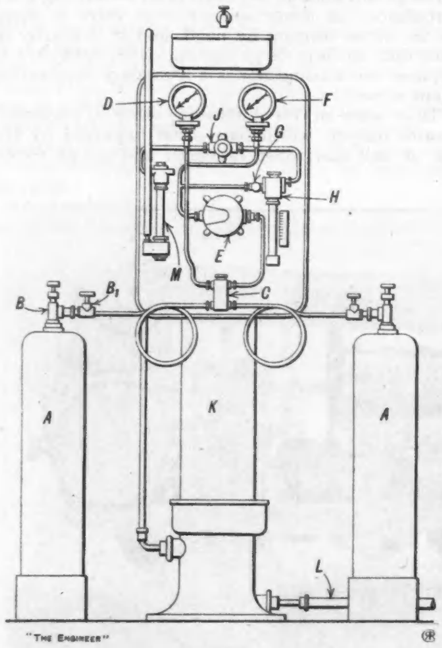


FIG. 43—DIAGRAM OF CHLORINATOR

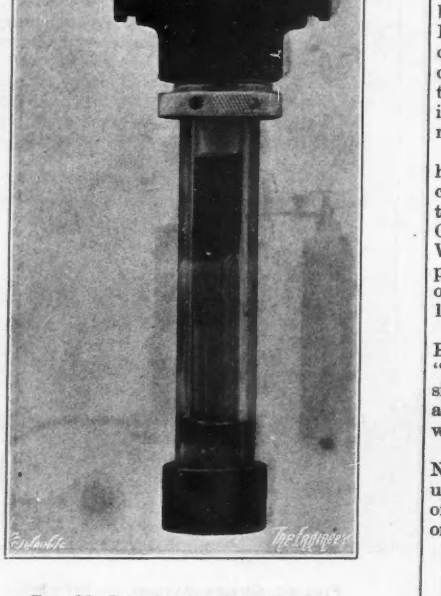


FIG. 44—PULSATING GAS METER

The meter—see Fig. 44—is of the pulsating type, and consists of two tubes placed one inside the other, the inner tube having a small syphon pipe fused inside it, as shown in the illustration. The gas passes down the outer tube and depresses the liquid therein until it reaches the bottom of the syphon, when the gas rushes through to the centre tube, the pressure is thus reduced in the outer tube and the liquid returns to its original level. The pressure then again builds up in the outer tube, forcing down the liquid, and the cycle is repeated. The number of pulsations per minute is counted and the amount of gas passing is given on a table according to the number of pulsations. The pulsating meter is capable of measuring very small volumes of gas and has a range of approximately 30 to 1. The volume of each pulsation is controlled by the syphon pipe and the capacity of the meter may be altered by inserting another centre tube with a longer or shorter syphon as may be desired.

There were also on this stand some little air compressors, designed much after the fashion of a centrifugal pump, and arranged to be directly driven by electric motors for supplying air to filter beds for aeration and agitating purposes.

THE SHEEPBRIDGE COAL AND IRON COMPANY, LTD.

There were several interesting exhibits on the stand of the Sheepbridge Coal and Iron Company, Ltd., with works near Chesterfield, which included a small gyratory crusher for surface dressing for roads, so compact that it can be mounted on a lorry and easily moved from point to point to make a store of dressing for use as required. This crusher is of the Kennedy type, for which the Sheepbridge Company holds the British manufacturing rights, and is characterised by the fact that there is only one, belt-driven, moving part. The crushing cone is mounted on a vertical shaft, which is given a rotary and excentric movement within the casing. The bearings are completely flooded with lubricant in such a way that there is no possibility of grit getting into the rubbing faces.

Another interesting product of the firm, which was, however, not demonstrated *in corpus* on the stand, but was shown by illustrations, is a machine for making concrete blocks which are truly waterproof. The essential idea is that the block or slab is made in a mould and subjected to violent vibration to consolidate it. It is then placed on the travelling table of the machine, passed under a screeding roll to level out its surface, and then under a larger "callendering" roll to squeeze and compact it. The result is a surface which is said to be absolutely impervious to water and a finish equal to that of hand-tooled stone.

SOME OTHER EXHIBITS.

Holman Brothers, of Camborne, Cornwall, had an extensive display of pneumatic machinery, both for compressing air and for utilising it for rock drills and such purposes, including compressing sets driven by both electric motors and oil engines. Dennis, of Guildford, had two gully emptiers and a refuse collector mounted on chassis of 12ft. 6in. and 9ft. 6in., of which the former has a tank divided into two compartments for 400 gallons of clean water and 300 gallons of sludge; and Fodens Ltd., of Sandbach, Cheshire, had two refuse collecting vehicles, one driven by a 46 H.P. petrol engine, and the other by a Dorman engine of 58 B.H.P.

Barford and Perkins, Ltd. (with whom, it will be remembered, are now associated Aveling and Porter, of Rochester), were showing a number of road rollers, but, with one exception, they are driven by internal combustion engines, either of the compression-ignition type, or for petrol. It is noteworthy that the majority of the oil-driven rollers were of comparatively light weight.

Both Electricars Ltd., of Lawley-street, Birmingham, and Commer Cars, Ltd., of Luton, had refuse collecting vehicles, but it is sufficient to mention them as their construction is familiar to our readers. G. A. Harvey and Co., Ltd., of Greenwich Metal Works, London, S.E.7, had an appropriate display of perforated metals, and emphasised, on the occasion of our visit, that they are able to make pressings 10ft. 6in. in diameter by 1½in. thick.

The Lea Recorder Company, Ltd., of Cornbrook Park-road, Manchester, 15, had a display of a "standing wave" water flow recorder, and some other similar apparatus, but as we hope soon to give some account of the latest developments in this direction, we will not enlarge upon the exhibits here.

Among the cranes shown were some from R. H. Neal and Co., Ltd., Ealing, ranging from 6 cwt. up to 1 ton, and some made by Thos. Smith and Sons, of Rodley, near Leeds, which we have described on previous occasions.

Literature.

The Analysis of Oil for the Production of Lubricants.
By ARTHUR A. ASHWORTH. London: Ernest Benn, Ltd. 1933. Price 9s.

THERE is undoubtedly a need for a standardised method for the analysis of crude oils and crude residua with the object of determining their lubricating oil content, but it is probable that more experimental work will have to be done before it would be safe to define a method as an international standard.

Mr. Ashworth gives a detailed description of the design of his laboratory vacuum tube still, and also full particulars of the operating procedure. The still consists of a steel pipe electrically heated, connected to a spray separating device and a condenser. The degree of vacuum is controlled by an automatic air bleed operated by a solenoid. The procedure is to take the residue of the crude oil after part of the gas oil has been removed by atmospheric steam distillation in a small capacity still. This residue is distilled through the vacuum tube still to yield a single distillate from the residue. The complete distillate is then treated for removal of naphthenic acids and subjected to acid refining, after which it is fractionated by redistillation in a vacuum capacity still. Clay treatment takes place during the latter distillation.

This is claimed to represent the most up-to-date large-scale practice, and to be preferable to methods whereby the fractionation takes place in the dephlegmator of the tube still. There is some doubt as to whether the majority of refinery technicians would agree with this claim, but there is no doubt that the procedure lends itself to laboratory scale work.

The book is very clearly and simply written; the technology is sound and at the same time practical. Many useful hints are contained in the text and greatly enhance the value of the work. The subject is, of course, highly specialised, and consequently such a work cannot be expected to have a very wide circulation, but after taking this into consideration the price still appears rather high for a book of sixty-odd pages.

The Rise of Metallurgy, with Special Reference to Sheffield Discoveries, Inventions, and Research.
By Sir ROBERT HADFIELD, Bt., F.R.S. London: Chapman and Hall, Ltd. 1933. Price 5s.

AT the September meeting of the Iron and Steel Institute in Sheffield Sir Robert Hadfield presented to all the members and visitors an address of welcome to the East Hecla works. It was a stout brochure dealing with Sheffield and its principal industries, and altogether an edition of 1000 copies was printed. Since then another edition of the same number has been published, and is available to the public, the profits on the sales going to charities.

The first edition was remarkable for the collections of portraits which it contains, but in the second the number has been increased by the reproduction of a portrait, obtained after much difficulty, of Professor W. H. Greenwood, who was the first Professor of Metallurgy, 1886–89, in Sheffield University. His successors were Dr. J. O. Arnold, 1889–1919; Dr. Desch, 1919 to 1932, and now Professor J. H. Andrews. Amongst other Sheffield educationists whose portraits are reproduced, we note the names of Mark Foster, Sir Frederick Mappin, Sir William Clegg, and Sir Henry and Colonel H. K. Stephenson.

Whilst the text of the volume deals with the ancient and modern history of Sheffield, its outstanding feature is certainly this collection of portraits, which begins with one of Cardinal Wolsey, who arrived at the Manor House in November, 1530, and soon after "left under escort on the last stage of his tragic journey." Wolsey is followed by a reproduction of the National Portrait Gallery's picture of Mary Queen of Scots, who, between 1570 and 1584, spent many weary years in the Turret House as Shrewsbury's prisoner. The Turret House is known in Sheffield now as Queen Mary's Lodge, and Sir Robert gives an exterior and interior view of it. Even Geoffrey Chaucer figures in this gallery for no larger reason than his well-known reference to a "Shefeld thwytel," and to Benjamin Huntsman a page is given. As the pioneer of crucible steel, the debt which Sheffield owes to him is incalculable. Here we find, too, a reproduction of the plaque of Faraday, who carried out that astonishing investigation of alloy steels with which Sir Robert himself has dealt so faithfully in his book "Faraday and his Metallurgical Researches."

The other portraits range over the world. Here we find a group of Americans, all Bessemer Medallists, Holley the first and Schwab the latest; for France we are taken back to de Réamur, of 1683, and down through a succession of Bessemer Medallists, all bearing world-famous names, to Charles Frémont, who received the great award in 1921. Germany, Sweden, Italy, Japan, Holland, and Russia all contribute portraits of men who have made their mark in the field of metallurgy, or the iron and steel industries. It would be quite impossible to mention all the other portraits to be found in this "album," but we must not overlook the page reproduction of an admirable painting of Sorby. Many of the men here shown are still living, and not a few of them, we suspect, would like to be as young as when they sat to the camera.

The text of the volume pays particular attention to the Iron and Steel Institute, to the interests of which Sir Robert has devoted much care, but at the same time sketches in a useful manner the rise and development of that great industry which has made Sheffield what it is to-day, and at one time placed Great Britain in the forefront of iron and steel-producing countries.

IT is reported from Dublin that a jobbing plumber in that city has recently acquired oxy-acetylene equipment, and he is the first in Dublin to do so.

Railway and Road Matters.

THERE was a collision on the morning of Thursday, November 16th, between a light engine and a passenger train at Hove, Southern Railway.

WE understand that the French "Super-Mountain" locomotive, exhibited publicly early in the year, has not yet been put into service on the Cherbourg line because it has been found necessary to carry out certain road reinforcements.

THE rolling stock renewal programme of the London, Midland and Scottish Railway provides for 2000 12-ton open wagons, with underframes constructed wholly of British steel. They will be fitted with the vacuum brake to enable them to be used in high-speed freight trains.

THE traffic receipts for the forty-fifth week show the following increases in goods receipts:—Great Western, £18,000; London, Midland and Scottish, £33,000; London and North-Eastern, £55,000; Southern, £2000. The L. and N.E.R. had an increase of £9000 also in coal receipts; under that heading the three other companies had little change.

THE tour of the "Royal Scot" in Canada and the United States came to an end on its arrival at Montreal on November 11th, which city it had left on May 1st. Additionally to its five-months' stay at the Chicago Exhibition, it has been on view at eighty places, has been inspected by over 3,000,000 people, and has travelled more than 117,000 miles under its own steam.

IN three week-end stages, commencing on Saturday, November 25th, the Southern Railway will relay the "North Kent East" Junction of the main and Greenwich lines between London Bridge and New Cross, one of the busiest spots on the Eastern Section. The week-end of December 2nd–4th will probably be the high spot of the job. It will see 200 men working hard against time.

IN seeking for sanction by the Railway Rates Tribunal for the introduction of an experimental schedule for the conveyance of livestock in the Gloucester area, it was stated that the conveyance of livestock had practically left the railway companies since the introduction of efficient motor transport specially made for the purpose, except in cases of large consignments for long-distance traffic.

THE London Passenger Transport Act has so widened the area of the London Traffic Commissioner's control that advantage was taken of the Road and Rail Traffic Bill to abolish the Southern Traffic Commissioner. There was considerable opposition to this on the ground that it would cause confusion, inconvenience, and expense, but Mr. Oliver Stanley assured the House that that was not so; moreover, there would be a saving of £3000 a year. The proposal was agreed to.

THE Road and Rail Traffic Bill received the Royal Assent before Parliament was prorogued on Friday, November 17th. One of the amendments made in the House of Lords was that a driver's statutory rest hours must be taken during a period when the man was not under the direction of his employer. Efforts had been made to get this inserted in the Bill when before the House of Commons, but the Government refused, so the acceptance of the amendment made in the Upper House gave general satisfaction.

DURING the three months ended March 31st last the assistant inspecting officers of the Railway Department of the Ministry of Transport inquired into forty-four of the more serious accidents to railway servants. There were twenty-two fatal cases, and as in one instance three men were killed, the total number of fatalities was twenty-four. Twelve accidents were considered to have been due to want of care, eight to misadventure, and one to an error of judgment. In the triple fatality the look-out was insufficient, as the ganger himself was also acting as look-out.

THE Railway Rates Tribunal has recently had to decide whether what are officially known as motor coaches—in contrast to trailer cars—used in electric traction, are, as contended by the manufacturers, "railway vehicles running on their own wheels," or, as claimed by the railway companies, "railway motor carriages with engines combined running on their own wheels." The Tribunal, on November 14th, gave judgment in favour of the latter opinion on the ground that the vehicles were primarily for the purpose of hauling or propelling a train, and not for the conveyance of passengers.

Two questions as to the electrification of railways were addressed to the Minister of Transport on November 15th. In answer to one, Mr. Stanley said that the companies had assured him that they were continuing to give consideration to that matter. He had not, however, any information with regard to any schemes of main line electrification which were likely to be proceeded with in the near future. The other question asked if the scheme for electrification in the L. and N.E.R. suburban area included the branch to Tottenham and beyond. The response was in the negative, but the whole answer is of interest in that it spoke of the schemes at present under consideration by that company "and the Standing Joint Committee set up under the London Passenger Transport Act."

THE reference, under "Sixty Years Ago" in our issue of November 3rd, to the railway "disasters" that occurred during and about October, 1873, may be supplemented by the observation that, even in these latter days of greater safety in railway travel, the term "disaster" would not be applied to any of the railway accidents that occurred at that time. Whilst there were fifteen accidents during 1873, only that of August 2nd at Wigan, which involved the death of thirteen passengers, could be described as a disaster. In eight only one life was lost in each accident, and the maximum, other than Wigan, was one where four passengers were killed. It is true that in the following year the Royal Commission on Railway Accidents was appointed, but that was not inspired by any particular accident or accidents; rather was it a concession to the then Earl de la Warr for the rejection by a Select Committee of his Regulation of Railways (Prevention of Accidents) Bill, the passage of which would have anticipated the requirements compulsorily enforced by the Act of 1889.

Notes and Memoranda.

WRITING on the subject of drilling deep holes, Mr. H. C. Bullock, in the *Machinist*, says that where a high pressure of lubricant is not available, it is advisable to encourage a slight chatter of the drill to keep the chips moving.

NEW specifications of the American Society for Testing Materials for bridges call for steel having a tensile strength of 60,000 lb. to 72,000 lb. per square inch, with a yield point of not less than 33,000 lb. The steel must be made either in the open-hearth or electric furnace.

THE telescope for the new McDonald Observatory on Mount Locke, in south-western Texas, will be built by the Warner and Swasey Company, of Cleveland. It will be the second largest in the world, and will cost approximately 325,000 dollars. The main mirror will be 80in. in diameter.

THE first 42,000-kW section of the Trebovice steam station in the Ostran-Karwin coalfield of Austria brings a new high-pressure plant into operation. It has three Loeffler boilers, each capable of providing 126,000 lb. of steam per hour at 1985 lb. per square inch and 932 deg. Fah. Two three-stage condensing turbines connected to 6300-volt alternators are used.

AN investigation has been carried out by the United States Bureau of Mines on the viscosity of natural gas, and a copy of the report thereon may be obtained from the Government Printing Office, Washington, price 5 cents. The experiments were carried out at various temperatures from 40 deg. to 80 deg. Fah. and showed that the viscosity ranged from 0·00000646 to 0·00000866 lb. per sec.-ft., depending upon the chemical composition of the gas.

THE North Bridge, Edinburgh, has been reopened for traffic after undergoing repairs which have taken six months to complete. The work, which has cost £35,000, was made necessary by rain water eating into the steel of the bridge underneath the roadway and creating a situation which, sooner or later, would have become dangerous. The old deck girders have been removed and new standard steel joists substituted, providing a beam of greater strength and rigidity, and giving a saving in weight of about 50 per cent.

Two interesting "Shorterising" (see THE ENGINEER, February 3rd, 1933) jobs have been recorded. The first was for cast iron bricks, 24in. by 3in. by 1½in. hardened to a depth of ½in. These bricks formed part of a cast iron bed or shoot where coke was discharged from the furnaces, the abrasive action of the coke wearing out the untreated parts very quickly. The second case was the "Shorterising" of cast iron rollers for plugging clay at a colliery brickworks. These rollers were originally made of steel with ½in. diagonal rib, and after two years the rib was worn flush with the bare plate. The company concerned is now having two new rollers made, 2ft. by 16in. by 1in., in cast iron and will have them "Shorterised."

MR. J. E. HAYGARTH, emphasising the importance of the use of lanolin in paint, urged that it maintained a continuous film; its viscosity was such that it did not run off easily; it had no chemical drawbacks which might cause rusting; it would emulsify and thus absorb surface moisture; it did not crack and allow rusting to occur along the cracks; it was non-drying; did not set hard, but could be hardened by the addition of up to 10 per cent. of wax, such as paraffin wax, if necessary; and it was cheap, plentiful, and British. He knew of a number of cases where it had been used as a paint on girders; in the opinion of those who had used it, it lasted very much better than ordinary paint—it had proved to be the best thing tried. Further, it had been used on ships' bottoms as a rust preventer, but appeared to have an attraction for barnacles.

A VISION of the future by Dr. F. Bergius, as he gave it to the Institution of Chemical Engineers! Having worked the wood hydrolysis process satisfactorily in large units, and having studied many different types of wood and waste wood, and solved the problem of good heat economy, we possess, said Dr. Bergius, the fundamental knowledge for reliable calculation. In countries in which wood is obtainable in large quantities, for instance, the Baltic States, Roumania, the North-West of the United States and Canada, wood sugar can be produced at a lower price than cane sugar is produced in the countries of the torrid zone. Also in England glucose can be produced at an extremely low price from imported wood. The wood sugar represents not only a cattle food, but at the same time is a source for the production of yeast as well as of glucose for human consumption. Hence the fundamental elements for human food can be procured from raw materials which Europe possesses in abundance. For the over-populated industrialised European countries, therefore, the wood hydrolysis process may become an important factor towards independence of a food supply from abroad in the same way that the coal hydrogenation process will in some degree ensure independence of a foreign oil supply.

CERTAIN American abrasive manufacturers are, according to the *Machinist*, now using an "electrocoating" process for making abrasive paper. The process, it is said, has made possible 60 per cent. increased efficiency on some jobs, while the average improvement is from 30 to 40 per cent. over the results obtained with products previously coated by sifting grain on to the fresh glue. The backing, after being coated with adhesive, passes between two plate-shaped electrodes. It is positioned nearest to the upper or positive plate with its coated side toward the negative plate. The abrasive particles are carried between the electrodes on the upper surface of an endless belt. A high-tension electrostatic field is maintained. As the particles enter the field they are electrified and caused to take a position with their long axes perpendicular to the surfaces of the two belts, parallel to lines of force in the field which distributes them in an even pattern. The action of the field then propels them toward the backing strip where they are embedded, point out, in the adhesive. As a result of this method of manufacture, the surface of the new coated abrasives presents the maximum number of cutting points to the work. The even distribution of the particles improves the quality of the work produced.

Miscellanea.

THE Pretoria, South Africa, City Council proposes to expend £350,000 on electricity extensions.

THE estimated production of benzol from the gasworks at Manchester, Liverpool, Oldham, Stretford, and Padiham is over 800,000 gallons a year.

A NEW lighthouse is to be built at Talaimannar, Ceylon, at a cost of Rs. 14,500. It is to be of cement and sand bricks and will replace an iron structure.

A PAPER factory is to be put up on the Umgeni River, Natal, for the use of sugar bagasse produced locally. The projected output of paper is 15,000 tons a year.

THE new harbour at Vizagapatam is to be formally opened by the Viceroy of India in the middle of December. It has a depth sufficient for vessels of 29ft. 6in. draught.

A NEW society has been formed under the title of the Anti-Noise League. The Chairman of this body is Lord Horder, and the offices are at 18, Old Cavendish-street, W.1.

Two of the six Southampton flying boats ordered by the Turkish Government have left the Supermarine Aviation Works (Vickers), Ltd., Woolston, Southampton.

A NEW coal pit has just been sunk, to a depth of 750ft., on the bank of the river Blyth, Northumberland, by the Cowpen Coal Company, and is intended to produce 3000 tons of coal a day.

THE new road bridge over the river Teesta, on the way from India to Sikkim and Tibet, was opened on October 26th. It is a reinforced concrete arch of 300ft. span and is the first of its size in India.

EXPERIMENTS are being made in South Wales in the use of oxy-hydrogen and oxy-coal-gas processes for the melting of lead in hydraulic presses used for the manufacture of lead-covered cable.

THE headquarters of the American Society for Testing Materials are being moved to more commodious offices at Atlantic Building, 260 S, Broad-street (N.W. Corner, Broad and Spruce Streets), Philadelphia.

THE bore-hole which is being put down on the Rand by West Witwatersrand Areas, Ltd., has arrived at a depth of over 2500ft., and a recent survey has shown that its deflection from the vertical is only 4 deg. at the bottom.

IT is proposed to build a new bridge across the Gorai River near Kustia Station, on the Poradaha-Goalundo section of the Eastern Bengal Railway. It will replace a bridge built by Sir Bradford Leslie in 1869 and will have four spans of 350ft.

A SYNDICATE of Liverpool business men, it is announced, has been formed to erect what will be the largest exhibition hall in Britain. The cost will be in the neighbourhood of £450,000. The Liverpool Corporation has offered a 33-acre site on the new East Lancashire Road.

A RECORD is claimed by John Lysaght's Normanby Park Steel Works, Scunthorpe, Lincolnshire, where, one night during October, there were rolled 433 tons of material in an eight-hour shift. During one week in the month the works rolled 5121 tons of steel, also a record.

THE Birmingham section of the British Industries Fair, which is to be opened at Castle Bromwich on February 19th, is to be divided up into four sections for engineering, metals, quarry, roads and mining, and transport. Each is to have its separate entrance and car park, but the whole Fair will, of course, be free to any visitor.

A COMPLETE train is to be equipped as an exhibition of British goods and will commence a tour of the southern half of England, following the British Industries Fair. A similar train will tour the North later and plans are being made for tours on the Continent and in the Dominions. The first train will be composed of seventeen coaches and will be adapted to house about a hundred exhibits. There will be a reception room, a dining car, and a coach carrying the electric lighting and power plant. The train will leave Birmingham on March 14th.

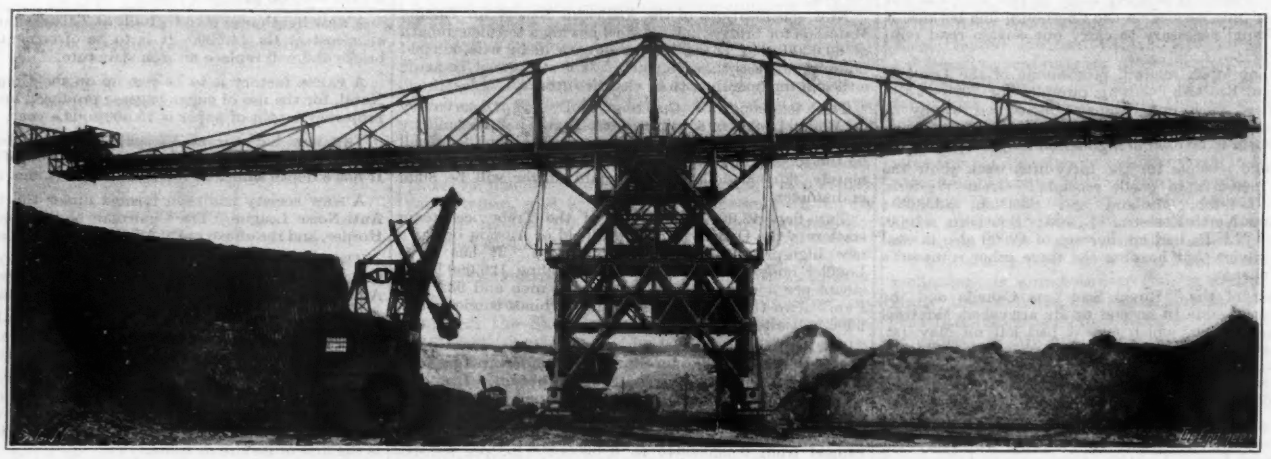
THE fiftieth anniversary of the world's first machine-propelled submarine may be celebrated this year in Sweden. After many unsuccessful attempts to construct submarines in different countries, a prominent Swedish engineer and arms manufacturer, Thorsten Nordenfelt, succeeded in building the first real submarine, which was launched in the Maelar Lake near Stockholm in the late summer of 1883. Mr. Nordenfelt, who owned large armament works in England and was one of the most important military inventors and constructors of that time, built a submarine that was 64ft. long, 9ft. wide, and had a displacement of 60 tons. It could be submerged 50ft. below the surface, was propelled by a 100 H.P. compound steam engine, and moved with a speed of 4 knots under water. It carried an outside torpedo, that could be launched by a mechanical contrivance, had a crew of three men, and could keep below the water for six hours. Instead of a periscope it had a small glass cupola, large enough for the captain's head. The first submarine was sold to Greece. The following year Turkey and Russia ordered two each.

DISCUSSING the question of "What is needed to make the low-temperature carbonisation of coal a national industry," at the meeting of the Institute of Fuel, held at St. Ermin's Hotel, on Tuesday, November 14th, Mr. John Roberts expressed the view that direct State aid was unnecessary, but the moral support of the Government would be a great help. He considered that a carbonising corporation should be formed, having sufficient financial backing to erect plants in every coalfield, of such type and size as to be suitable for the coals available and the proximity of the market. Under such a scheme the plants to be erected should be selected by a committee of technical experts, including one representative of the Fuel Research Board and one from the Coalowners' Association. The corporation should have a central publicity department and sales organisation, together with a research department under its own control. It should keep a close watch on new developments at home and abroad, in the treatment of coal and its derivatives, and any process warranting trial should be thoroughly tested.

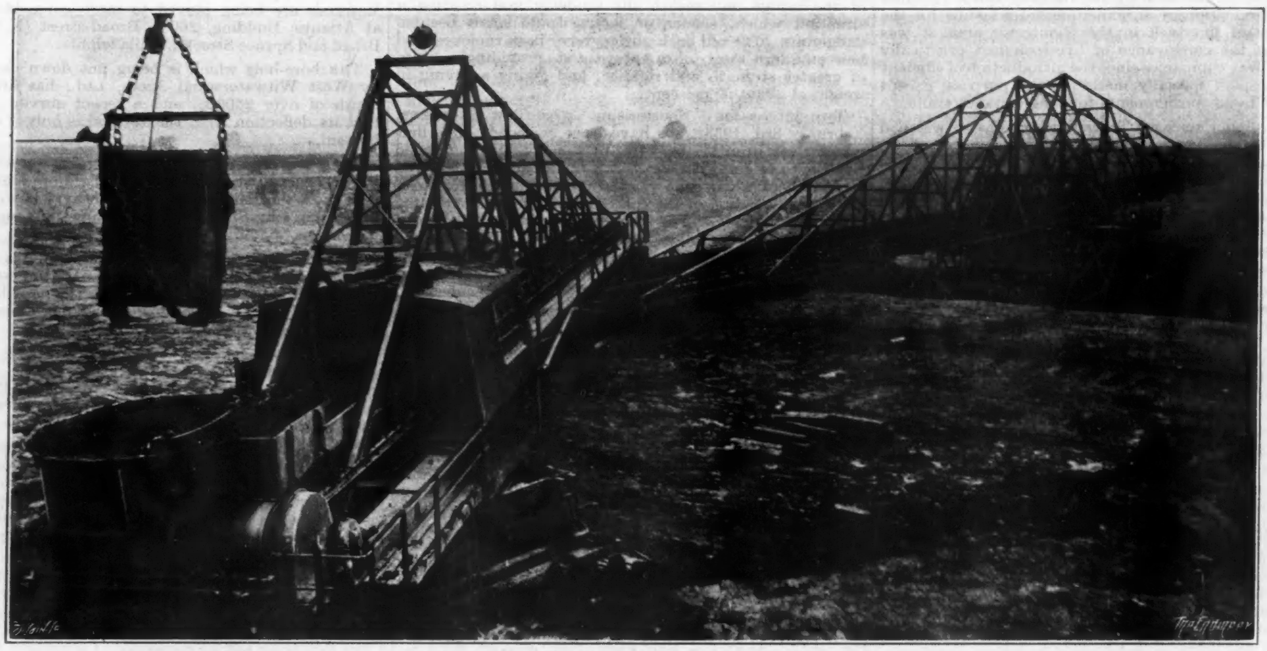
CANTILEVER CONVEYOR AT A BRICKFIELD

ROBERT BOBY LTD., BURY ST. EDMUNDS, ENGINEERS

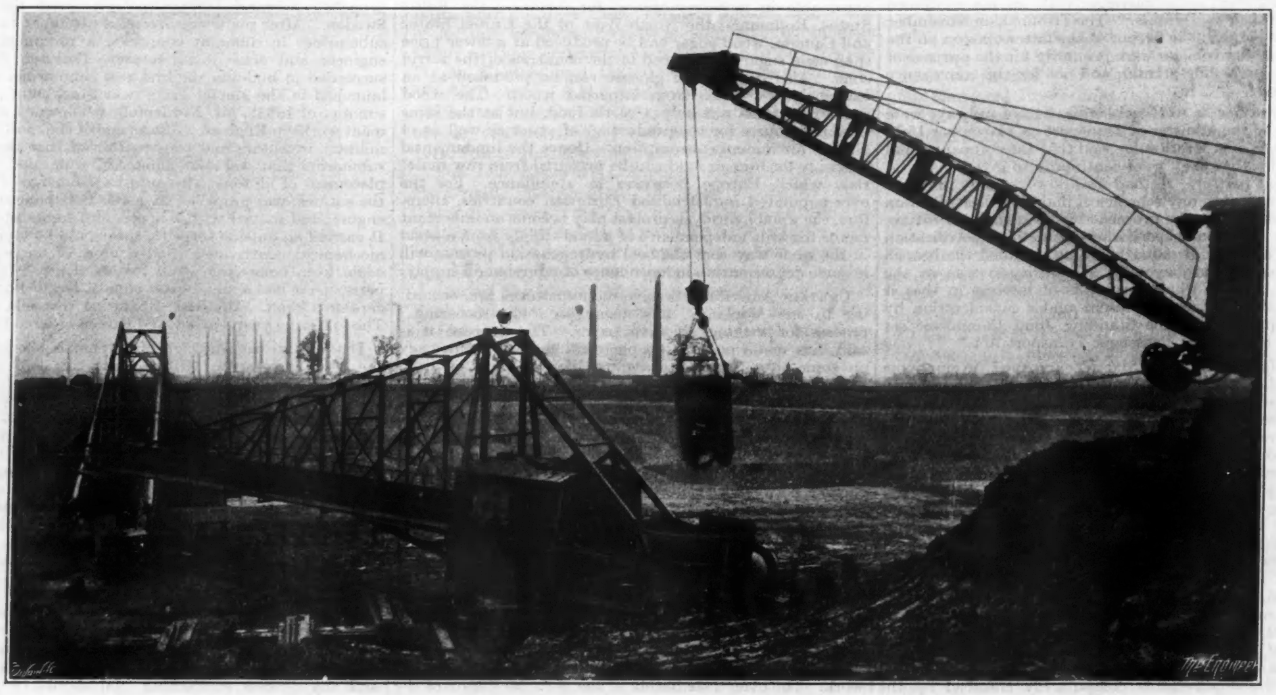
(For description see page 530.)



THE MAIN CONVEYOR



THE FEEDING AND MAIN CONVEYORS



THE TWO CONVEYORS AND THE DRAGLINE EXCAVATOR

The Engineer

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LARGER CRUISERS.

An announcement of considerable moment in its bearing on naval policy was made by the First Lord of the Admiralty in Parliament last week. It had reference to the cruiser programme for the current year, which, as voted in March, made provision for one "Leander" class ship of 7250 tons and three "Arethusas" of 5400 tons, armed with eight and six 6in. guns respectively. Had this programme been completed in its original form, it would have given us eventually nine "Leanders" and five "Arethusas," authorised in the period 1929–33, the aggregate being 92,250 tons; though, in fact, the slightly lower displacement of the earlier "Leanders" would have reduced the actual total to about 90,000. In ordinary circumstances these fourteen ships would have represented a valuable reinforcement to the Navy, which is urgently in need of more cruisers. But, however good a warship may be in itself, and the "Leander" class at any rate appears to be an excellent design, its true value can be judged only by comparing it with contemporary vessels of other navies. When that test is applied, neither the "Leander" nor the "Arethusa" can be considered satisfactory. Their displacements are respectively 30 and 50 per cent. lower than those of the largest foreign cruisers now on the stocks and their armament is proportionately inferior. The "Leander" is smaller and feebler than any foreign cruiser, excepting those building in Italy, while the "Arethusa" is a veritable minnow among the tritons. Neither class, therefore, can be regarded as a good investment. Up to now we have been building only second-rates—to adopt the ancient terminology—while every other naval Power has been launching first-rates. This is so radical a departure from traditional policy that it calls for explanation.

The reason was clearly stated by the First Lord last week. "The policy of building cruisers of comparatively small tonnage had been adopted in the hope that other nations would follow our lead. Also it will be recalled that in July, 1932, the United Kingdom delegation at Geneva put forward proposals for the reduction of future cruisers to 7000 tons, with a maximum gun calibre of 6·1in., in the hope that these would be generally accepted. Unfortunately, neither of these hopes has been realised." He went on to give specific instances of the manner in which foreign Powers were forcing up the tonnage and armament of the cruiser type. Japan has legislated for six ships of 8500 tons, reported to mount fifteen 6in. guns; the United States has gone one better by ordering four ships of 10,000 tons, also with fifteen 6in. guns, and at the same time pushing forward with the construction of several 10,000-ton cruisers armed with nine 8in. guns. To these examples might be added that of France, who has just launched the cruiser "La Galissonnière," the first of a group of six ships displacing about 8000 tons and mounting nine 6in. guns in triple turrets. Compared with all these powerful ships, the "Leander" and the "Arethusa" cut a singularly unimpressive figure. While it is the devout hope of every sane being that none of the vessels mentioned will ever have to fire a shot in anger, the fact remains that warships are designed with a view to certain contingencies, and for that reason must bear some relation in weight and hitting power to possible antagonists. Quite apart from the purely military aspect, there is the question of prestige to be considered. The spectacle of diminutive British cruisers alongside vastly superior ships of other nations is one that has become too common in certain harbours overseas, and the effect is not beneficial to this country. The assurance implicit in the first Lord's statement that the policy of deliberately building cruisers of inferior type is to cease will be hailed with satisfaction by all who have the national interest at heart. Unfortunately, some time must elapse before the consequences of our well-meaning, but, as is now avowed, futile attempt to bring about universal naval limitation by unilateral action can be rectified. That mysterious clause in the London Naval Treaty, binding us, alone among the signatory Powers, not to complete more than 91,000 tons of new cruisers by the end of 1936, has placed the Admiralty "on the horns of a very serious dilemma," to quote the First Lord's own words. Our quantum of tonnage is so restricted that it was impossible to re-design all four cruisers of the current programme on a 9000-ton basis without exceeding the allowance. The number had therefore to be reduced to three, and even then one must be of the diminutive "Arethusa" class. We believe, however, that the Admiralty's decision will command wide approval. It is true that numerical strength in cruisers is desirable, having regard to the extraordinary length of the Empire's trade routes, which literally girdle the globe. On the other hand, it would be the negation of wisdom to continue building ships which were definitely inferior in fighting power to any possible commerce raider. At least twice during the Great War valuable convoys were cut to pieces after their naval escort had been overwhelmed by stronger enemy ships; while the fate of the "Pegasus" at Zanzibar and of the "Good Hope" and "Monmouth" at Coronel should warn us never again to match inferior ships against opponents of heavier metal. Much as the action of foreign Powers in building large cruisers is to be deprecated from the point of view of disarmament, at least it has had the advantage of dispelling some of the illusions which have hitherto made a muddle of our defence policy. It is no longer possible to doubt that in cutting down our armed forces we have given encouragement to other Powers to expand their navies and air fleets. Command of the sea, even though it be only local, is such a tempting prize that no country is to be blamed for trying to grasp it. If Great Britain is finding the trident too heavy, others will be only too ready to relieve her of the burden. It should, however, be clearly understood that without adequate national defences we should have no voice in the direction of world affairs, and our influence, which is wholly on the side of peace, would cease to carry weight. These are considerations to which we invite the earnest attention of our disarmament zealots. Not for a moment do we credit the United States or Japan or France with warlike intentions, yet the fact remains that one and all are energetically developing their naval and air forces. They are obviously doing so with the idea, not of attacking their neighbours, but of rendering themselves more secure against attack, knowing security to be the most potent deterrent to war.

The decision to build two large cruisers and a small one in place of one medium and three small vessels involves no increase in the aggregate tonnage of the 1933 programme, which remains approximately at 23,400. Nor will there be any increase in the original estimate of cost; on the contrary, a slight reduction is anticipated. Particulars of the new class of 9000-ton cruisers will be awaited with interest. That the design will present features novel to the British Navy seems certain. We assume that naval officers will not be satisfied with less than twelve 6in. guns, which would be quite a moderate armament for ships of this tonnage, and in that case the adoption of triple mountings would appear to be unavoidable. Admittedly there are drawbacks to the triple turret, especially in the case of quick-firing guns, but they are probably outweighed by the advantages in respect of economy in space and weight. The three-gun turret for 6in. weapons has already been accepted by the United States, French, and German navies, and it is evident that Japan has adopted the same system in her new 8500-ton cruisers, which are, so it is reported, to carry fifteen 6in. guns. Our new cruisers promise to be enlarged versions of the "Leander" class, with a pair of triple turrets forward and aft. This arrangement ought to leave a reasonable margin for armour protection, provided the designers are content with a speed of, say, 31 knots. No case has yet been made out for a higher speed than this, and it is noteworthy that all the latest foreign cruisers are slower than their predecessors. It is to be hoped that the cruisers of next year's programme will also be of substantial tonnage. Any ships authorised then will not be subject to the limiting clause in the London Treaty, and this new freedom will afford Great Britain an opportunity of demonstrating to the world her resolve to maintain to the full that measure of naval power which has been left to her by a series of one-sided, and, in our view, inequitable covenants.

Superheated Steam in Locomotive Service.

When dealing with the first of the new "Pacific" type locomotives recently built at Crewe for passenger traffic on the London, Midland and Scottish Railway we had occasion to comment on the proportions of the superheater, and the effect of superheated steam on the water and fuel consumption. This engine, as we pointed out, follows in general design the practice of the Great Western, which is, of course, not surprising, in view of its designer's long association with that line and the successful locomotive types which have emanated from the Swindon works. There has, however, always been a distinctive difference between Swindon practice in the matter of superheater proportions and in the steam temperatures employed and that obtaining on other lines, including that for which Mr. Stanier's engine was designed, and this fact would appear to have caused a certain amount of discussion on the relative merits of what may be termed high and low superheat temperatures. This, however, by no means opens up a new question, and, judging from the working results obtained with steam carrying a high degree of superheat compared with that less highly superheated, it would certainly seem that the advantage lies with the former.

When the superheater came into general use, now some twenty years ago, it was very soon shown to produce very startling results in the matter of fuel economies, and in this country the paper on this subject contributed by Sir Henry Fowler to the "Proceedings" of the Institution of Civil Engineers in 1914 clearly indicated the gains accruing from the use of the Schmidt type of flue tube superheater. We do not propose to refer to this paper in detail, but following upon some remarks we made in our impression of July 21st, relative to certain locomotives formerly built at Crewe, we quote some figures given by the late C. J. Bowen Cooke, who stated during the discussion on Sir Henry's paper that with 357 tons at 60·5 miles per hour the consumption of coal with one of his superheated engines on a run from Crewe to Euston was 39·6 lb. per mile. We now quote the same speaker on a previous occasion when the working results with the Whale "Precursor" class were given. These engines were stated to burn on an average 57·53 lb. per mile, when hauling express trains of about the same weight at slightly lower speeds and working between the same points. The significance of these figures lies largely in the fact that the two engine types compared were, for all practical purposes, exactly alike, for it will be recalled that Bowen Cooke's four-coupled engines were in reality superheated "Precursors," having 20½in. as against 19in. cylinders. Probably the most elaborate series of tests made to establish the advantages to be obtained from the use of superheated steam were those carried out on the testing plant at Altoona. They were made with the deliberate intention of determining the relative values of different degrees of superheat. The engine employed was of the "Pacific" type, and a large number of trials were run at a definite speed and at various cut-offs, while, in order to show the effect of superheat alone on performance, the boiler was successively fitted with flue tube superheaters of different sizes, so that the amount of superheat could be varied independently of the rate of working. A study of the results is of interest. In general, it is shown that at any given cut-off an increase in superheat decreases the steam rate, and that for a given steam pressure an increase in superheat increases both the heat available and the heat utilised per pound of steam supplied to the cylinders. From these tests it seems that when using steam at 200 lb. gauge pressure and superheated 214 deg. Fah. the cylinder efficiency at 25 per cent. cut-off is 70 per cent., and the corresponding water rate 16·1 lb. per I.H.P.-hour, while at the same speed and cut-off. but with 115 deg. superheat, the cylinder efficiency is reduced to 62 per cent., the water per I.H.P.-hour being increased to 19·6 lb. A further point of interest also shown is that an increase in the superheat at a given rate of cut-off does not adversely affect the boiler efficiency; in other words, although an increase in superheat means for a given boiler an increase in the size of the superheater, the actual percentage of the heat in the coal fired which is given, each pound of steam remains substantially equal. It seems that on balance, although the heat transfer across the superheating surfaces is materially less per square foot than across the water heating surfaces, the boiler efficiency is equalised on account of the lower coal consumption for any given engine conditions or power output, which, of course, improves the furnace efficiency. Yet another point to be noted is the heat in the exhaust. Naturally, an increase in initial steam temperature means that for any given rate of expansion there will tend to be a greater temperature in the steam as exhausted. This condition is a source of loss, and can only be recovered in part by a feed heater. On the other hand, however, it would not appear proper to level this as a charge against the use of highly superheated steam, for although there can be, and frequently is, superheat present in the exhaust, and hence a high heat content per pound of steam exhausted, yet the total heat wasted in this manner may be, and in fact is, relatively low on account of the reduction in the weight of steam supplied to the engines per unit of power developed.

A study of the performance of the locomotive as a whole, when operating with steam having different degrees of superheat, reveals numerous other points of interest, not the least of which is the fact that as the superheat is increased, the steam and fuel consumptions when compared with the power developed become more constant—that is to say, curves drawn through the plotted points depicting the coal and water rates are relatively flat, showing a smaller rate of increase between the limits of maximum and minimum powers than do those for a less superheat, which tend to assimilate such curves drawn for a locomotive using saturated steam, which rise rapidly as the cut-off is lengthened, and the rate of power output increased. Judging from the experimental data on this subject so far available, results point to the desirability of combining high superheat with short cut-offs, if minimum fuel rates are to be realised, but the economic limit does not appear to have been determined.

Heat Liberation and Transmission in Boilers

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Friday evening of last week, Messrs. E. W. Robey and W. F. Harlow presented before the Institution of Mechanical Engineers a paper entitled "Heat Liberation and Transmission in Large Steam Generating Plants." Elsewhere in this issue we reprint in a slightly abridged form the first portion of the paper dealing with the liberation of heat in steam generators. The second portion dealing with the heat transmission aspects will be reprinted in a succeeding issue. Neither the manner in which it was summarised by Mr. Robey nor the trend of the discussion which ensued did the paper full justice. Mr. Robey rapidly read selected extracts from it without intercalating a single word to cover the many and important passages which were omitted. Even to one who came to the meeting fully prepared by a previous study of the paper this process of presentation proved highly confusing. To others who had not so prepared themselves there was some evidence that it resulted in their being misled as to the real contents of the paper and the authors' opinions and findings. The discussion, following the process of decimation to which the paper was subjected by its own authors, maintained on the average a low level.

Major W. Gregson, M.Sc., said that steam was still the dominant method of obtaining power, and that therefore any improvement in steam-raising technique must react favourably on industry in its widest sense. From the title of the paper the authors had attempted to cover a very wide field. Hence, in view of their space limitations, it was unfair to expect them to have enlarged on a number of the points mentioned, many of which were certainly of a controversial nature. The authors, in dealing with the important question of heat release per unit of furnace volume, stated that the size and rating of a combustion chamber was a function of secondary air admission and of the mixing of the air and the combustible substance. They appeared to view secondary air admission as a recently developed idea, which was surely not correct. Again, they were not clear as to the *method* of mixing—an all-important function. Should excessive turbulence be aimed at ? He, the speaker, considered that turbulence brought about by excessive centrifugal action was wrong, as the tendency at higher speeds was diametrically to oppose true intermingling of the particles. The centrifugal action set up caused differential sorting according to densities on the lines of the centrifugal separator. That fact probably explained why the efficiency of an oil burner fell off so quickly at ratings above its normal output; that was to say, when centrifugal action tended to separate out air and oil vapour particles. The ideal way to get intimate mixing was by diffusion, and the authors' reference to the Hammond system, where perfect diffusion was sought, presumably showed that they were thinking on those lines.

As a humble disciple of the teachings of Professor Osborne Reynolds and Dr. Nicholson, he could not subscribe to the authors' statement that little attention had been paid until quite recently by practical engineers to the application of high gas velocities to boiler design. He could refer to generic types of boilers which were the result of the logical development of the high gas velocity principle and which were well established in industry. He fully agreed with the authors when they stated that the amount of heating surface was no criterion of boiler capacity, but that the manner in which it was arranged was what really mattered. That fact was best exemplified by the high gas velocity type of boiler, in which the heating surface relation—cross-sectional area to length of gas passage—was entirely different from that appertaining to low draught boilers. To adopt high gas velocities in a boiler fundamentally designed for low speeds was, of course, asking for trouble; the surface could not properly take advantage of the higher speeds and extra molecular activity, due to speeds above the critical velocity. All that would happen in that case would be excessive draught on the fire, high back-end temperatures, and lowered efficiency. With high velocities coupled with a suitable arrangement of heating surface higher heat transmission was obtained owing to intimate molecular contact.

Continuing, the speaker showed a slide demonstrating the heat transmission from a single smoke tube set in a compartmented box, an experiment which, he said, showed conclusively the high extraction efficiency due to a velocity corresponding to approximately 4in. draught loss through the tube and also the uselessness of adding to heating surface beyond the economic figure; that was to say, when the heat transmission curve flattened out. The whole idea of specifying boiler duties by heating surfaces was, he maintained, an utter fallacy, and often resulted in completely redundant heating surface being supplied. It placed good boiler design on a level with bad practice when schemes were being compared. The output of the heating surface of a boiler depended firstly on the correct arrangement for the gas velocity adopted and secondly on the ability of the actual surface to absorb the heat. The latter factor turned entirely on clearing the steam away from the heated surface as soon as it was formed and replacing it by solid water; in other words, the heat-absorbing capacity was a function of the circulation. A boiler with good circulation could be safely run at high ratings, whereas a boiler with poor or indefinite circulation ran grave risks of overheating if it were run at anything beyond low transmissions.

Finally, he commented on the authors' method of computing economic gas velocities. His own system, he said, whenever steam-driven induced draught fans could be applied, was to take the steam at the fan prime mover equivalent to that required for preheating the boiler feed from hot-well temperature to, say, 185 deg. Fah. and calculate back the permissible fan duty to suit; that was to say, so that all the fan steam was returned to the boiler as hot feed, with consequently no debit for the service. The rule worked admirably in practice and avoided complications.

Professor G. V. Lomonossoff said that as an old locomotive engineer he had read the paper with great satisfaction, for he found in it evidence to the effect that locomotive boiler practice, previously scoffed at as unscientific and conservative by stationary plant engineers, was now being followed by those self-same critics. Intense forced draught, all-metal water-cooled walls, thick coal beds, and the use of secondary air were all characteristic of the locomotive and had been since Stephenson's time. He then proceeded to compare the authors' results with those which he had obtained from experiments on locomotive boilers. He had found that with some fuels, especially soft coals, secondary air gave very good results, but that with anthracite and oil, steam acted better than air when delivered above the fuel bed. Dealing with the theory of heat transmission, he said that in the general formula $K=C_1V^n$ for the rate of heat transfer K in terms of the mass-velocity V, the value of n had been taken by different authorities, including himself, at from 0·5 to 0·8. In reality, a straight line formula of the type $K=K_0+C\,V$ fitted the results of his own tests much better than any exponential form. He had been very doubtful, too, of the accuracy of the formala, namely, $\Delta=C_2V^2T$ adopted by the authors for the draught loss, for, according to his own experiments, the mean absolute temperature T of the gases was a function of the mass-velocity V, namely $T=T_0+a\sqrt{V}$. Combining that expression with the authors' formula, one obtained the expression $\Delta=A\,V^2+B\,V^{5/2}$, whereas his own formula had been $\Delta=A^1V+B^1V^{5/2}$. For wood and oil as fuel, he found that the coefficient A^1 was almost zero, and therefore in these cases his own and the authors' formulæ practically coincided. During the previous few days he had re-examined his results, and had to admit that, except in the case of anthracite, the authors' formula gave better coincidence with the experimental figures than his own. Continuing, he remarked that he could not agree with the authors' statement that the laws governing the transfer of heat by radiation in boiler furnaces were more obscure than those governing transference by convection. In his opinion the theory of radiation, owing to the success of the quantum theory, was now much clearer than that of convection. In Germany, in the light shed by the fuller knowledge now available concerning transmission of radiant heat, basic changes had been introduced in the design of metallurgical furnaces.

Among others who took part in the discussion was Major S. J. Thompson, who told the meeting that about ten years ago his firm had started to make stokers for the boilers which they produced, because of the troubles which they encountered in the stokers supplied to them from outside sources. He had to confess that they were still encountering troubles. The truth was that a stoker could be designed and arranged to burn perfectly one particular type of coal, but not to deal equally satisfactorily with all types which it might be desirable or economical to burn on it at different times. There was no doubt that the development in the use of powdered fuel had been responsible for the recent improvements made in the design of stokers. Stoker design had slipped into a rut from which the rivalry of powdered fuel had forced it to emerge.

Mr. Parry dealt chiefly with soot blowing and the corrosion of air heaters. He maintained that there was no mystery about dew point temperatures. The dew point could be calculated exactly from a knowledge of the composition of the gases. The process of re-circulation of the air adopted by the authors to overcome corrosion troubles was, he maintained, not a preventative, but a palliative.

Mr. Weber asked whether the after-burning in flue gases at low temperatures was to be ascribed to the combustion of gases, or of solid particles of fuel. Presumably, he said, it was the result of the combustion of solid particles, because it was stated that it was not found in the flues of oil-fired plants.

Mr. B. Samuels said that not long ago he was blamed for using 20 per cent. of secondary air. To-day, the authors invited him to use as much as 50 per cent. He maintained that as much of the air required for combustion as possible should be introduced through the fuel bed in order that it might become intimately mixed with the combustible substances.

In the course of a brief reply to the discussion, Mr. Robey dealt with the possibility of using as much as 40 per cent. of secondary air. With present designs of chain grate water-tube boilers it was perhaps quite correct to say, as some of the speakers had stated, that it was not possible or desirable to use more than 30 per cent. That figure, however, represented the secondary air admitted as such. Adventitiously admitted air, Mr. Robey maintained, would bring the real amount of secondary air up to 40 per cent. In Lancashire boilers more than 40 per cent. of secondary air had been used, and it was noteworthy that as the percentage was increased, the CO_2 content of the flue gases rose. Dealing with the question raised concerning the cause of after-combustion in the flue gases, he said that it was undoubtedly due to the burning of particles of carbon and of gases previously not consumed.

The Sulzer Single-Tube Steam Generator.*

By Professor A. STODOLA, Zurich.

No. II.

(Concluded from page 500, November 17th.)

Testing the Regulation.

In order to carry out thorough tests on the regulation of the boiler described in our last issue, it was equipped with the following measuring devices :—

(1) Temperature and pressure measuring apparatus at nine points of the tube.

(2) Recording thermometers before the injection point and at the steam outlet.

(3) Continuous recording indicators at the same points as (2).

(4) Continuous recording indicator for measuring the regulating oil pressure of the two thermostats, either of which could be connected to the instrument at will.

(5) In addition to the measurements with these devices, direct readings were taken of the position of the servo-motor pistons for injection and feed-water regulation and for the by-pass valve.

In order to imitate the behaviour of a boiler which is working under the influence of the centrifugal governor of a turbine, sudden changes in load were caused by extinguishing or lighting two oil burners, which were capable of raising together 4 tons of steam per hour, and at the same time temporarily setting the feed-water delivery by hand, leaving the final adjustment to the regulating apparatus.

In the greater number of tests, the coal firing on the grate was adjusted to generate as nearly as possible a constant amount of 3·5 to 4 tons of steam per hour, and then the rate of evaporation was suddenly increased to 7·5 tons per hour by bringing the two oil burners into operation ; the rate of steam raising was thus nearly doubled. Extinguishing the two burners again reduced the rate of generation suddenly to about one-half.

The necessity of retaining the coal firing for generating a base load, adversely affected the smoothness of the curves obtained, since the state of equilibrium was disturbed, first of all by the coal heaped on the stoker from the underfeed coal passage, and also by the gradual formation of clinker at the more or less burnt out "holes" on the grate.

The steam turbine of the works was stopped during these trials, and the whole quantity of steam was led through the by-pass valve into the low-pressure steam transformer already mentioned.

By a simple adjustment of cocks the regulating device could be used as shown in Fig. 12 or in Fig. 13. We discuss first of all the curves which were obtained with the latter.

A. *The end thermostat acts on the injection regulator (with isothermal compensating motion) ; the intermediate thermostat acts on the differential regulator and together with this on the feed-water regulator (also with isothermal compensating motion), as per arrangement Fig. 13. The pressure regulation is in operation.*

(1) *Reducing the rate of steam raising from 7·6 tons per ton to 4·3 tons per hour, i.e.* from 100 to 57 per cent. by shutting down two oil burners and at the same time temporarily setting the feed-water delivery to 4·6 tons per hour, leaving the final adjustment to the regulating devices—see Fig. 15. In order to obtain a more complete idea of the circumstances, we follow the course of these curves separately, while the curves referred to below speak for themselves. On the temperature curve of the intermediate thermostat it will be noted that shutting down the two burners, as was to be expected, makes itself manifest by a sharp drop in temperature from 370 deg. to 330 deg. Cent., *i.e.*, by 40 deg. Cent. The consequent reduction of the feed-water delivery to 3·8 tons per hour causes the intermediate temperature to rise immediately, but, because of the delayed arrival within the evaporating zone, this rise in temperature lags about 2 min. behind the minimum quantity of feed water delivered and finally reaches 400 deg. Cent. The regulating operation is then repeated with diminishing fluctuations, and the state of equilibrium, both as regards temperature and quantity of water delivered, is reached after about 15 min.

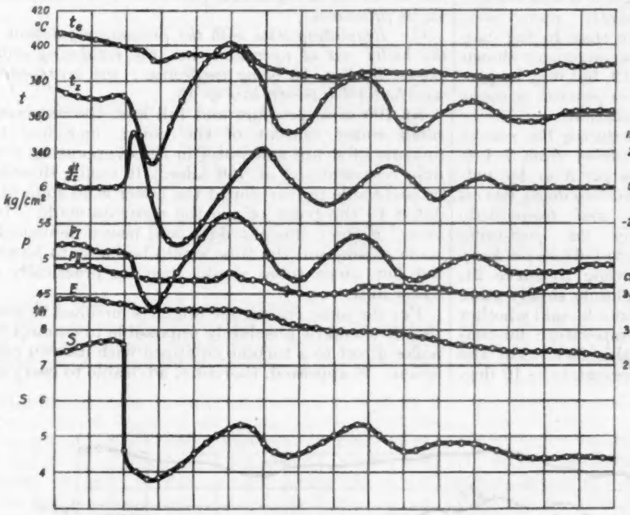
At the superheater outlet the temperature falls with slight fluctuations in the course of about 6 min. from 400 deg. to 381 deg. Cent., *i.e.*, by 19 deg. Cent., and then recovers particularly slowly, showing that the oil brake of the injection regulator was evidently too effective, and a period estimated at about 40 min. was required for a complete recovery. This was also apparent from the still incompleted movement of the injection servo-motor piston, *i.e.*, of the injection needle.

In the other curves attention should be called to the excellent agreement between the intermediate temperature read directly by thermo-couples (curve t_z) and the pressure curve of the regulating oil coming from the intermediate thermostat (curve p_I) ; the latter is an indirect measure of the former. This proves that the thermostat follows the steam temperature almost instantaneously, and that its control gear reproduces very accurately in the pressure curve the expansion corresponding to the changes in temperature that occur.

The diagram of pressure fluctuation of the regulating oil at the intermediate thermostat, given in Fig. 16, shows, in agreement with the other curves, the characteristic course of "damped oscillations." The thickness of the curves is conditioned by the action of the pulsator, which causes the indicator piston to make small fluctuations, the harmonic curves of which, however, run together into a thick line, because of the very short wave lengths.

Finally, the pressure curves marked $d\,t/d\,z$ of the additional regulating oil controlled by the differential regulator, which should have amplitudes proportionally equal to this differential quotient, show that this stipulation is also well complied with. The functioning of the separate elements of the regulating arrangement is thus proved to be excellent. During further tests with reduction in load on the boiler, and still slighter changes in temperature, falls of 8½ deg. Cent. could be observed.

(2) *Increasing the load on the boiler from 4·4 tons per hour to 7·0 tons per hour,* i.e., *from 63 to 100 per cent., by suddenly starting up two oil burners and temporarily setting the feed-water delivery by hand to 6·5 tons per hour.* From the curves in Fig. 17 it can be seen that the excessive increase in the firing causes at first a rise of temperature at the intermediate thermostat, which, through the regulation, increases the quantity of feed water delivered. This causes a fall of temperature, which, however, occurs about 1¼ min. later, so that the feed-water delivery and the temperature phase differ by about 180 deg. The lag is smaller than it was when the load on the boiler was reduced, since the increased speed of the feed water causes the water to remain for a shorter time in the tube. Taken absolutely, the lag is actually smaller than the time required for passing through the preheating zone, but greater than the time for passing only through the evaporating zone.



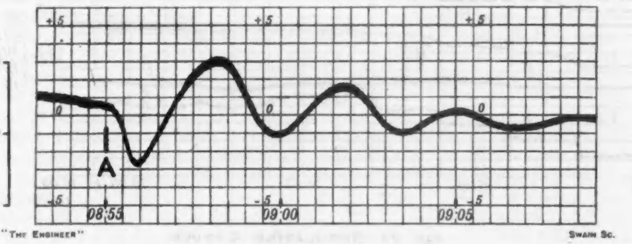


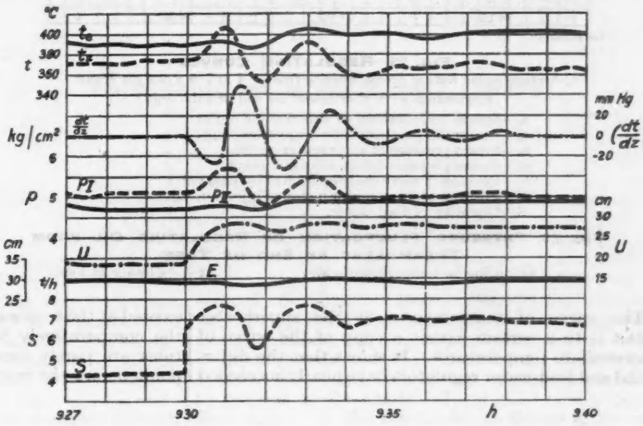
Fig. 15—Regulating Curves

Reducing the Rate of Steam Raising from 7·6 to 4·3 Tons per Hour.

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_I—Regulating-oil pressure from intermediate thermostat.
p_{II}—Regulating-oil pressure from thermostat at end of tube.
$\left(\frac{dt}{dz}\right)$—Regulating-oil pressure of the differential regulator.
E—Position of servomotor piston of injection valve.
S—Quantity of feed water.

Fig. 16—Pressure Fluctuation of Regulating Oil from Intermediate Thermostat

(p_I—According to temperature scale). At A—Change in load.



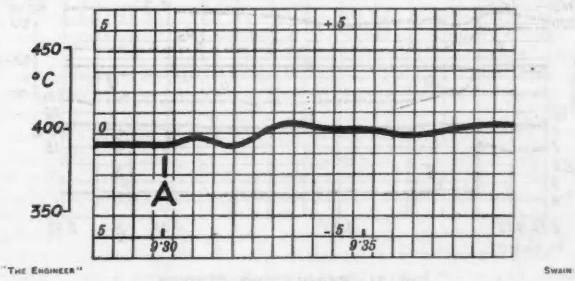


Fig. 17—Regulating Curves

Increasing the Rate of Steam Raising from 4·4 to 7·0 Tons per Hour.

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_I—Regulating-oil pressure from intermediate thermostat.
p_{II}—Regulating-oil pressure from thermostat at end of tube.
$\left(\frac{dt}{dz}\right)$—Regulating-oil pressure of the differential regulator
U—Position of servomotor piston of by-pass valve.
E—Position of servomotor piston of injection valve.
S—Quantity of feed water.

Fig. 18—Pressure Fluctuation of Regulating Oil from Thermostat at End of Tube

(p_{II}—According to temperature scale). At A—Change in load.

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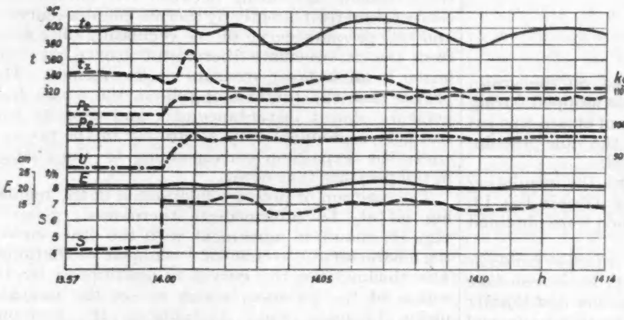
* Translated and abridged.

Although the intermediate temperature shows variations of +34 deg. and −22 deg. Cent. above and below the initial value, the maximum fluctuation at the superheater outlet is +15 deg. Cent., according to Fig. 18.



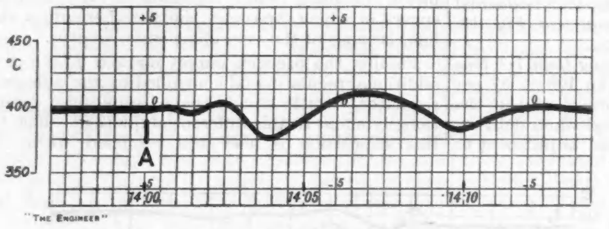


FIG. 19—REGULATING CURVES

Increasing the Rate of Steam Raising from 4·4 to 7·0 Tons per Hour.

(Regulation with thermostat at end of tube only).

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_e—Steam pressure at superheater outlet.
p_z—Steam pressure before injection point.
U—Position of servo-motor piston of by-pass valve.
E—Position of servo-motor piston of injection valve.
S—Quantity of feed water.

FIG. 20—PRESSURE FLUCTUATION OF REGULATING OIL FROM THERMOSTAT AT END OF TUBE

(p_{II}—According to temperature scale) At A—Change in load.

The curve of temperatures at the superheater outlet is to a certain extent a copy of the curve of intermediate temperatures. It shows that the differential and feed-water regulators have nearly succeeded in completing their tasks. It would be useful to investigate whether this favourable result is due to the appropriate quantity of feed water originally delivered.

B. *The intermediate thermostat is put in operation ; a thermostat at the end operates the injection regulator directly (with positive compensating motion), and the differential regulator ; in connection with the latter it also acts on the feed-water regulator (with isothermal compensating motion). See Fig.* 12 (ante). *The pressure regulation is in operation.*

(3) *Increasing the steaming rate from 4·4 to 7·0 tons per hour by suddenly putting two oil burners into operation and temporarily adjusting the feed-water delivery by hand to 7·3 tons per hour.*

Curves 19 and Fig. 20 show that the fluctuations of temperature before the injection point amounted to about +30 deg. and − 20 deg. Cent., and those of the final temperature to −24 deg. and +16 deg. Cent. These deviations are consequently more considerable than in the case of the arrangement shown in Fig. 13, but may be permitted in practice without any hesitation.

(4) *Reducing the rate of steam raising from* 7·1 *to* 4·4 *tons per hour by suddenly shutting down two oil burners and temporarily adjusting the feed-water delivery to* 4·6 *tons per hour.*

According to curve 21, no absolutely steady state existed at the beginning, and it cannot be said whether the comparatively very slight temperature fluctuations are partly conditioned by this fact. For the point before the injection they amount to −10 deg. and +8 deg. Cent., and for the superheater outlet to −17 deg. Cent.

(5) *Gradually increasing loading. Passing from* 4·1 *to* 7·6 *tons per hour in four steps within* 6 *min., the intensity of the firing being correspondingly increased in equally large stages.*—Expressed as a percentage of the maximum output, *i.e.*, 7·6 tons per hour, this means a total increase in the rate of steam raising of 46 per cent. in steps, each of 11·5 per cent., in a total time of 6 min.; such increases in load would not often occur in practice. According to Fig. 22, the maximum fluctuation of the temperature at the injection point is 34 deg. Cent., and at the superheater outlet 27 deg. Cent., with a very uniform fluctuation curve. The test with decreasing loading could therefore at once be started.

(6) *Gradually decreasing loading. Passing from* 7·2 *to* 4·2 *tons per hour in four steps within* 6 *min., the intensity of the firing being correspondingly reduced in equally large stages.*—According to Fig. 23, the temperature remained practically unchanged at the injection point. At the superheater outlet the variation from the initial value amounted to −20 deg. and +7 deg. Cent., which are practically very satisfactory figures.

In tests 3 to 6 the effectiveness of the differential regulator, with regard to the regulating pressure produced by it, was not clearly perceptible. The fluctuations of all servo-motor pistons caused by the vibrator are evidently very favourable in preventing any seizing, but, on the other hand, greatly affect the run of curves of regulating parts which are subject to slight pressures.

C.—Regulating tests with the pressure regulation on the boiler out of operation, i.e., *the regulating group shown in Fig.* 10 *being ineffective ; the arrangement used being that shown in Fig.* 13.

At 100 atm. pressure and full load the extremely small water content of the boiler, including the mixture of steam and water in the evaporating zone, may be estimated at 760 kilos. It might therefore be justifiable to fear that if the boiler were connected direct to the point of use the contents could "boil over" if there was a sudden and heavy demand for more steam, and the tube would be liable to become red hot, since there would then be practically no water in it.

For the same reason one might be inclined to think that it would be absolutely impossible to connect the boiler direct to a turbine equipped with its own regulation. It appeared, therefore, advisable to carry out

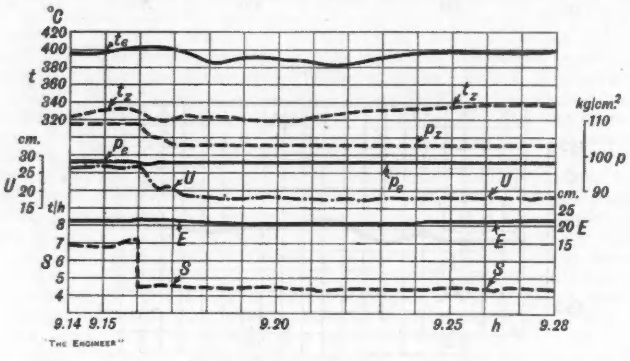


FIG. 21—REGULATING CURVES

Reducing the Rate of Steam Raising from 7·1 to 4·4 Tons per Hour.

(Regulation with thermostat at end of tube only).

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_e—Steam pressure at superheater outlet.
p_z—Steam pressure before injection point.
U—Position of servomotor piston of by-pass valve.
E—Position of servomotor piston of injection valve.
S—Quantity of feed water.

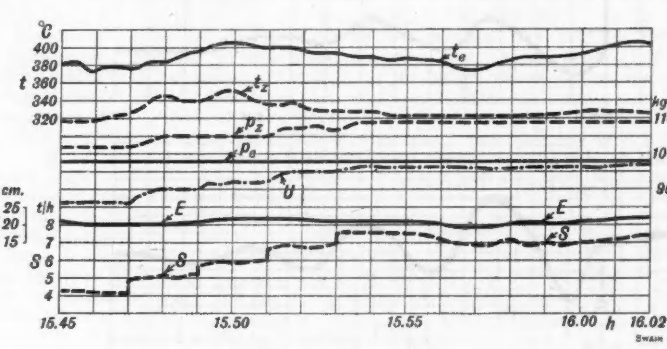


FIG. 22—REGULATING CURVES

Gradually Increasing the Rate of Steam Raising from 4·1 to 7·6 Tons per Hour Within 6 Minutes.

(Regulation with thermostat at end of tube only.)

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_e—Steam pressure at superheater outlet.
p_z—Steam pressure before injection point.
U—Position of servomotor piston of by-pass valve.
E—Position of servomotor piston of injection valve.
S—Quantity of feed water.

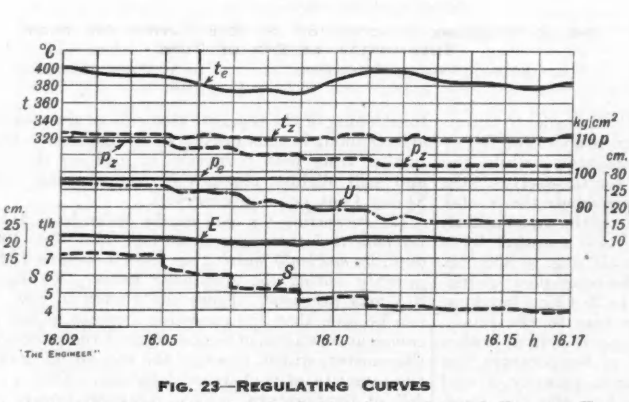


FIG. 23—REGULATING CURVES

Gradually Reducing the Rate of Steam Raising from 7·2 to 4·2 Tons per Hour Within 6 Minutes.

(Regulation with thermostat at end of tube only.)

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_e—Steam pressure at superheater outlet.
p_z—Steam pressure before injection point.
U—Position of servomotor piston of by-pass valve.
E—Position of servomotor piston of injection valve.
S—Quantity of feed water.

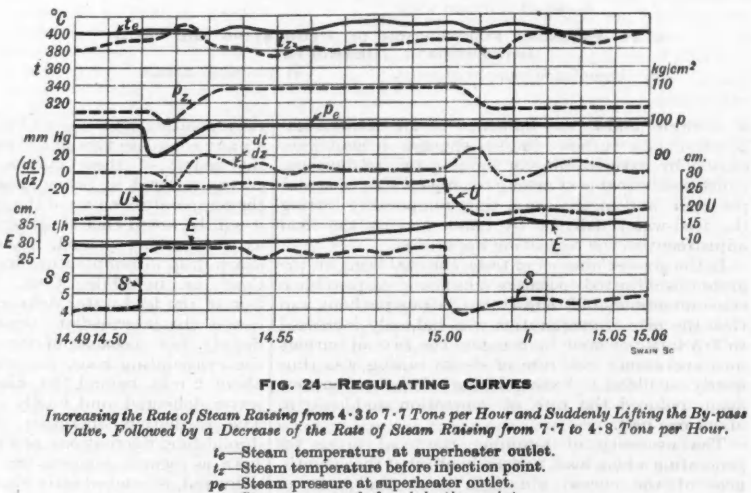


FIG. 24—REGULATING CURVES

Increasing the Rate of Steam Raising from 4·3 to 7·7 Tons per Hour and Suddenly Lifting the By-pass Valve, Followed by a Decrease of the Rate of Steam Raising from 7·7 to 4·8 Tons per Hour.

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_e—Steam pressure at superheater outlet.
p_z—Steam pressure before injection point.
$\left(\frac{dt}{dz}\right)$—Regulating-oil pressure of the differential regulator.
U—Position of servomotor piston of by-pass valve.
E—Position of servomotor piston of injection valve.
S—Quantity of feed water.

tests to see how much steam could be taken suddenly from the single-tube boiler while the steam pressure was, at the same time, falling. It may be said in anticipation that the results show that there is nothing to be feared in this respect.

The case where the boiler is directly subject to the control of a centrifugal governor was imitated by forcing open the by-pass valve at a certain moment, in order to allow a large quantity of steam (possibly the maximum quantity) to flow off. Naturally, the feed water delivery and the intensity of firing had at the same moment to be suited to the new demand for steam, just as they would have been by the self-regulation of the power set consisting of turbine and boiler.

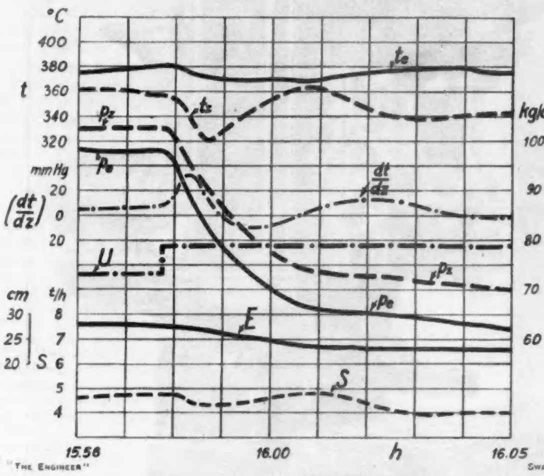


Fig. 25—Regulating Curves

Suddenly Lifting the By-pass Valve when Raising 4·8 Tons of Steam per Hour.

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_e—Steam pressure at superheater outlet.
p_z—Steam pressure before injection point.
$\left(\frac{dt}{dz}\right)$—Regulating-oil pressure of the differential regulator.
U—Position of servomotor piston of by-pass valve.
E—Position of servomotor piston of injection valve.
S—Quantity of feed water.

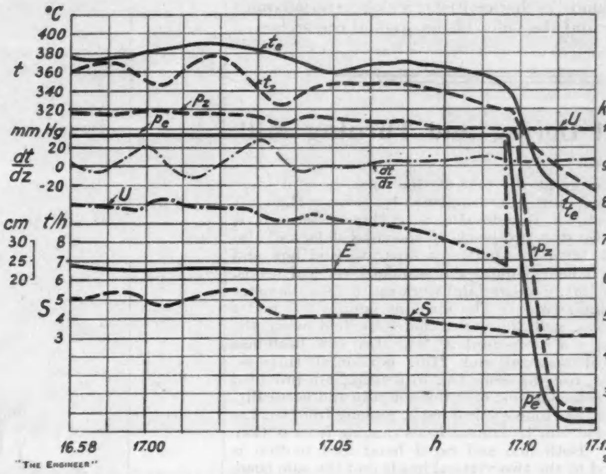


Fig. 26—Conditions in Boiler while Stopping

t_e—Steam temperature at superheater outlet.
t_z—Steam temperature before injection point.
p_e—Steam pressure at superheater outlet.
p_z—Steam pressure before injection point.
$\left(\frac{dt}{dz}\right)$—Regulating-oil pressure of the differential regulator.
U—Position of servomotor piston of by-pass valve.
E—Position of servomotor piston of injection valve.
S—Quantity of feed water.

The observations already mentioned in section A showed that it might be advantageous to adjust the oil brake on the isothermal injection regulator to act somewhat more freely. This change made itself evident at once in the greater promptitude with which the regulator acted. Even after only 10 min. such a satisfactory steady state was reached that an increase in the load on the boiler could be followed at once by a reduction of load.

(7) *Increasing the load from* 4·3 *to* 7·7 *tons per hour by suddenly forcing up the by-pass valve and lighting two oil burners, at the same time temporarily adjusting the feed water delivery to* 7·2 *tons per hour. After an interval of* 9 *min. reducing the load from* 7·7 *to temporarily* 4·8 *tons per hour and extinguishing two oil burners, leaving the regulation to take care of the closing of the by-pass valve.*—From Fig. 24 it will be seen that the temperature before the injection point when increasing the load has fluctuated +20 deg. and −18 deg., and when reducing the load −23 deg. and +8 deg. Cent. At the superheater outlet the temperatures varied, when reducing the load, by only +10 deg. Cent., and when increasing the load by −14 deg. Cent., these being the best results obtained in the whole series of regulating tests. The pressure before the by-pass valve has also fallen practically instantaneously from 98 to 90 atm., to rise again within 1½ min. to 98 atm. At the moment when the load was increased the cross sectional area of the by-pass valve was large enough to allow 7·7 tons per hour to pass through at a pressure of 98 atm. In consequence of the fall in pressure to 90 atm., the quantity of steam flowing through approximated only $7{\cdot}7\times 91/99=7{\cdot}08$ tons per hour, *i.e.*, taking 7·7 tons per hour as 100 per cent., the quantity of 56 per cent. flowing through rose immediately to 92 per cent. Since, in condensing turbines, in the neighbourhood of the point where $p=100$ atm. and $t=400$ deg. Cent., as long as the temperature remains constant, the adiabatic fall in pressure within wide limits alters only insignificantly, the results of this test mean that the present boiler, when working under the influence of a centrifugal governor, is capable of supplying instantaneously a quantity of steam corresponding to a sudden increase in the load on the turbine from 56 per cent. to 92 per cent., *i.e.*, by 36 per cent. of the maximum load. It will, however, be recognised that still far greater sudden increases in loading would be permissible without any risk of "boiling over," if it were possible at the start to increase the intensity of the firing and the quantity of feed water delivered. Since demands of this kind were not to be expected in the present plant, the feed water pump and oil burners which have been installed did not allow of such tests being made.

(8) *Still more severe testing of the boiler with respect to "boiling over."**—With a "base load" of 4·8 tons of steam per hour raised by the coal firing, and without changing the feed water delivery or the intensity of firing, the by-pass valve was suddenly opened wide and the boiler left to itself without pressure regulation. According to the curves in Fig. 25, the pressure at the superheater outlet falls in the course of about 3 min. from 98 atm. to 62 atm. and the other pressures and the temperatures accommodate themselves to the new steady condition with only insignificant fluctuations.

The test consequently proves the very important fact that even the sudden drop in pressure from 98 to 62 atm. does not lead to any "boiling over," and that the regulation is quite capable of coping with such sudden changes.

D.—Starting and Stopping the boiler.

Before starting the firing water is circulated through the boiler by means of the feed pump, after opening the above described by-pass valve. The surplus water delivered, along with the steam formed, is at the start led back to the feed water tank, where the steam is condensed. The boiler can then be left to regulate itself, as is shown by the pressure regulating diagram in Fig. 10.

Stopping the boiler.—When the steam temperature has fallen below the permissible height after the fire has been damped down the prime mover is stopped. In consequence of this the pressure in the boiler rises, and as soon as the rise has exceeded 2 atm. the by-pass valve opens automatically, as shown in Fig. 10. The small quantity of steam flowing away is condensed in the feed water tank, the capacity of which is, of course, chosen in such a way that the water in it cannot boil. The feed pump and the regulation remain in operation even some time after the fire has died out and the clinker has been pushed into the clinker hopper. Because of this the tube is cooled down in a short time and the heat accumulated in the setting passes away, so that the whole boiler can be left to itself.

The operations taking place while the boiler is being stopped are shown in Fig. 26. According to the amount of fuel still remaining on the grate—which fuel is turned until it has burned out—the superheat temperature will be maintained for a short time. After the by-pass valve has been fully opened the pressure falls to about 25 atm. in about 1½ min.

Obituary.

HAROLD MEDWAY MARTIN.

The death of Mr. H. M. Martin, which occurred at his home at Croydon on Friday last, takes from the profession a man of outstanding ability, and one whose loss will be felt far beyond the circle of his immediate friends. Modest and self-effacing to the last degree, he was hardly known by sight, except to engineers specially interested in the physical and thermo-dynamical sciences, of which he was an acknowledged master and an able exponent. From time to time his frail figure was to be seen at the meetings of the Institutions, though rarely or never of recent years unless he had been specially invited to speak on some subject which he had made his own. Then, fighting down his natural shyness, and alternating between a nervous hesitancy of speech and an almost explosive rapidity of utterance which was the despair of reporters, he would make his points with the directness born of knowledge and sincerity. His knowledge, both of engineering and other matters, was extensive, but his special interest lay in mathematical physics. Gifted by nature with exceptional mathematical ability, mathematics to him was a tool always sharp and available, and the more valuable in that he was its master and not its servant.

Mr. Martin was born in 1864, and received his early education at the Northern Congregational School, Wakefield. At the age of sixteen, he passed the London Matriculation Examination, and then entered the works of Messrs. Black, Hawthorn and Co., of Gateshead, locomotive and marine engineers, as an ordinary working apprentice. As the result of private study and evening classes he obtained, in 1885, a Whitworth Scholarship, which enabled him to proceed to the Central Technical College, South Kensington. To this scholarship he always attributed his own chance of getting a higher technical education, and he keenly felt the alleged injustice of the modern regulations which now make the scholarship impossible of attainment by the self-taught apprentice. Mr. Martin was also awarded the Clothworkers' Scholarship at the Central Technical College in 1885. Here he studied civil and mechanical engineering under Dr. W. C. Unwin, and mathematics under Professor Henrici, leaving in 1887 with the Diploma of the City and Guilds of London Institute. In the same year he joined the editorial staff of our contemporary *Engineering*, and remained with that journal until his death—a period of more than forty-six years. During this time he did original work on a great variety of subjects, the results being almost invariably published anonymously. He developed the theory of the short cylindrical boiler, in which the shell stresses are modified by the constraining influence of the ends. Other investigations included the strength of hooks, the strength of rotating discs, the steam leakage through labyrinth packings, the lubrication of gear teeth, and the theory of convergent nozzles at speeds beyond the critical velocity. An important piece of work was a formulation of the laws of heat transfer in condenser tubes, previously discordant results being shown to be explicable on a rational theory. Bridges and masonry dams also interested him, and he investigated the theory of the stiffened suspension bridge.

Steam turbines early attracted his attention, and he developed a theory for the design of compound reaction machines. His views were, indeed, held in high respect by turbine designers, both in this country and abroad, and his advice was frequently sought and as readily given. As an exponent or critic of other men's work, he also rendered invaluable services. No one has probably done more than he did to familiarise engineers with the physical and thermo-dynamic laws underlying the properties of steam, and to explain the rational formulæ of Callendar. His simple exposition of the "Elements of the Lanchester-Prandtl Theory of Aeroplane Lift and Drag" will not be forgotten by engineers interested in aeronautics, nor will an earlier generation fail to remember a really delightful little book on "Statically Indeterminate Structures and the Principle of Least Work," now out of print, in which the applications of Castiglione's principle were clearly explained. Mr. Martin's only other book was "The Design and Construction of Steam Turbines," now also out of print.

Among his other services to the profession, Mr. Martin served as member of the Steam Nozzles Research Committee from its inception, and was mainly responsible for the design of the sensitive and accurate testing apparatus with which the experiments were made. He was also an original member of the Sub-committee on Lubricants and Lubrication, appointed by the Government in 1917, and was responsible for initiating the experiments at the National Physical Laboratory on the effect of pressure on viscosity. He took a great interest in the Junior Institution of Engineers, joining as a member in 1907, and being given honorary membership in 1921. He was elected member of the Institution of Mechanical Engineers in 1930, and the distinction of Fellowship was conferred upon him by the Council of the City and Guilds of London Institute in 1931, on the grounds of his contributions to the advance of industry and the value of his original researches.

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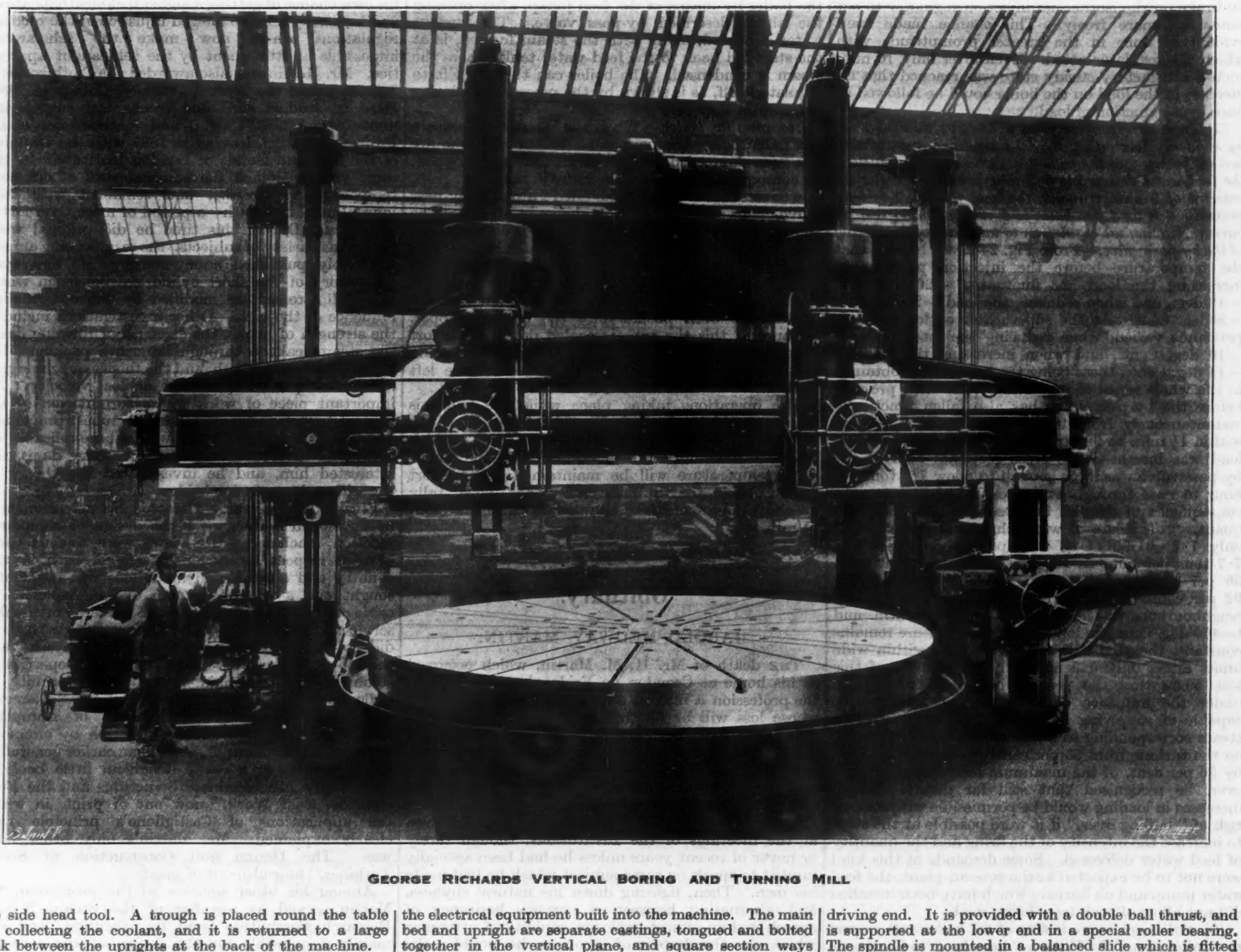
* "Priming" hardly conveys the meaning of the action.—Ed. The E.

Vertical Boring and Turning Mill.

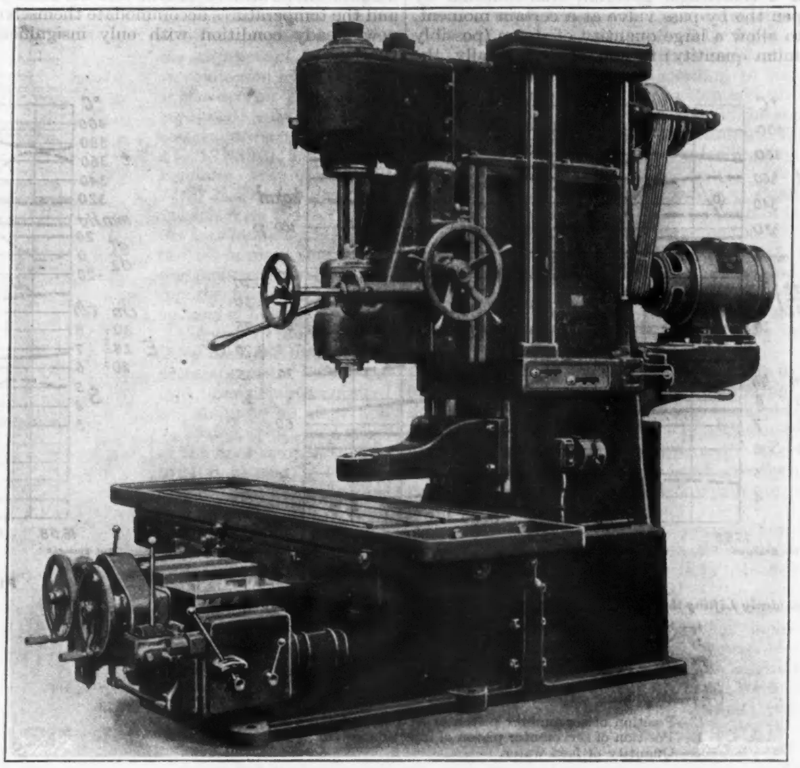
The engraving at the foot of this page shows a large vertical boring mill just completed by George Richards and Co., Ltd., of Broadheath, near Manchester. It is fitted with two standard heads on the cross slide, and also a side head, the latter having a separate feed box and being quite independent of the standard vertical heads. The table is 16ft. diameter and work up to 18ft. diameter can be accommodated. The machine admits 8ft. under the toolholders, and 9ft. under the cross slide, while the tool bars have a down feed of 5ft. The side head has 30in. vertical traverse and 27in. horizontal traverse. Twelve feeds, ranging from 1in. to 0·03in., are provided to the two vertical heads, both horizontally and vertically. The side head has four vertical feeds, ranging from 0·24in. to 0·07in., and four horizontal feeds ranging from 0·12in. to 0·036in. Both fine and rapid hand feed motion is also provided to the two vertical heads and the side head. In the case of the vertical heads these feeds can be applied from the operating platforms. Rapid power traverse is obtainable at all the heads, both vertically and horizontally, and this motion and also the raising and lowering motion to the cross slide is driven by a separate 15 H.P. electric motor mounted on top of the cross girth. The gear-box gives twelve mechanical changes of speed to the table, ranging from 10 to 0·8 r.p.m. The main driving motor, mounted on top of the gear-box, is 45 H.P., of the constant-speed type. Lubrication has received special attention. The gear-box has flood lubrication, and other main bearings in the base are supplied with oil by gravity feed, while the main table bearing has an oil reservoir fed by a drip feed lubricator. A rather unusual feature on so large a machine is the provision of a coolant system to the cutting tools. For this purpose there are two pumps driven from the main gear-box, one supplying coolant to the two vertical tools and the other supplying the side head tool. A trough is placed round the table for collecting the coolant, and it is returned to a large tank between the uprights at the back of the machine.



George Richards Vertical Boring and Turning Mill

High-Speed Milling Machine.

Fitness to purpose and cleanness of design are the outstanding characteristics of the motor-driven high-speed milling machine illustrated herewith. The machine is one of the latest types built in three sizes by Craven Brothers (Manchester), Ltd., Reddish, Stockport, for use with high-speed cutters. It is of the all-geared type, with the electrical equipment built into the machine. The main bed and upright are separate castings, tongued and bolted together in the vertical plane, and square section ways are provided for both the spindle slide and table. Unit construction has been adopted for the various sections.



Craven High-Speed Milling Machine

The gear-box on top of the upright provides sixteen changes of speed through heat-treated steel gear wheels mounted on splined shafts, the latter running in ball and roller bearings and starting and stopping being controlled by a friction clutch and brake.

The machine is driven by a constant-speed motor and a texrope drive to the clutch on the gear-box shaft, and the control mechanism is built into the upright. The spindle of high-carbon heat-treated steel is splined at the driving end. It is provided with a double ball thrust, and is supported at the lower end in a special roller bearing. The spindle is mounted in a balanced slide which is fitted to the square section ways on the upright, the slide having both fine and quick adjustment by hand, with quick locking arrangements and a vernier for setting the depth of the cut. The cutter mandrel support is designed for use on heavy profile and slab-milling operations. It is adjustable vertically, and when not required can be pivoted clear of the table.

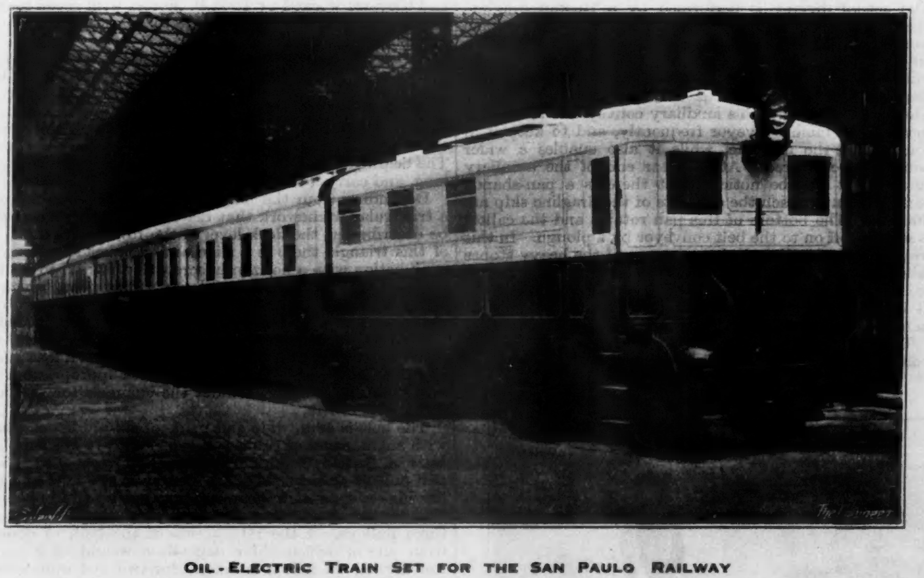
The transverse slide for the table has very wide ways and a taper strip adjustment. Screws of large diameter are provided for feed and quick traverse in both directions. Each screw has a ball thrust and the table can be easily adjusted in both directions by means of a hand wheel. The feed control and quick power traverse controls are by means of one lever of the "joy-stick" type. The feed is engaged by a drop worm having trip action which operates in any direction, and the quick traverse is engaged through friction clutches.

The feed gear-box provides sixteen rates of feed, from 1½in. to 24in. per minute, and there is a safety slipping clutch. Feed and quick traverse drives are obtained by a separate motor built into the feed gear-box, and a mechanical connection automatically disengages the feed, should the operator stop the spindle with the feed engaged. "One shot" pumps are used for supplying oil to the moving parts wherever possible, and in other places an oil gun is used. This machine is capable of removing 30 cubic inches of cast iron per minute when using a 12in. cutter of the high-speed type. Its principal dimensions are as follows:—

Diameter of spindle over splined driving end	4in.
Working surface of table	6ft. by 2ft.
Longitudinal traverse of table	5ft.
Transverse traverse of table	3ft.
Distance from centre of spindle to vertical slide of main frame	2ft. 3in.
Maximum distance, table to spindle nose	3ft.
Minimum distance, table to spindle nose	7in.
Number of spindle speeds	Sixteen
Range of spindle speeds	15–250
Number of feeds	Sixteen
Range of feeds	1½in. to 24in.
H.P. of driving motor	20
Speed of driving motor (approx.), r.p.m.	1200
Floor space occupied (approx.)	11ft. by 12ft. 9in.
Approx. net weight, exclusive of electrical equipment	10 tons

Oil-Electric Train Set for Brazil.

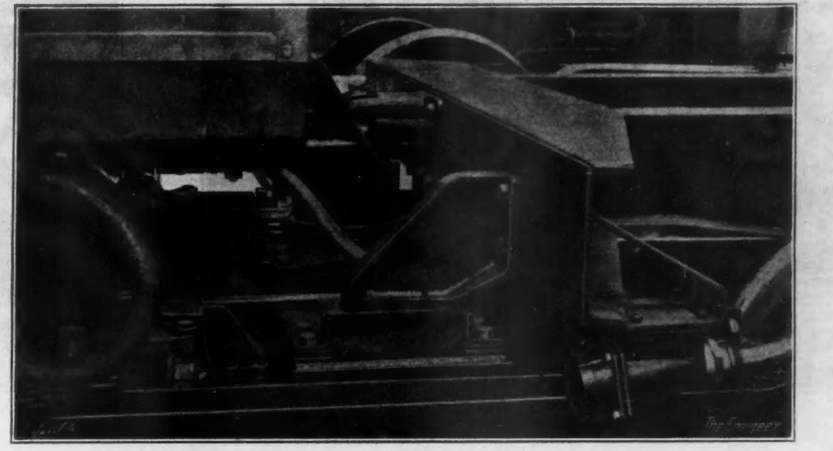
A VERY interesting oil-electric train set has recently been completed at the Scotswood Works of Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., for rapid and frequent services on the San Paulo Railway in Brazil between the port of Santos and San Paulo, a distance of roughly 49 miles. Owing to the exigencies of the service involving, as it does, the traversing of an incline of 1 in 12½ to an altitude of 2600ft. by means of a ropeway, it is necessary that the train set shall conform to very particular requirements, inasmuch as not only will it have to work at different altitudes at very short intervals, but owing to the length of passing loops on the line the overall length has to be restricted.



OIL-ELECTRIC TRAIN SET FOR THE SAN PAULO RAILWAY

The train set is of three-coach formation with a power unit articulated to the first coach. The second and third coaches also are articulated, whilst connection between the first and second coaches is by simple draw gear. The train set has been designed for a maximum speed of 65 m.p.h., the drive being by means of four motors, two being mounted on the bogie under the power unit and two on the rearmost bogie, thus spreading the tractive force over the whole length of the train. Current is supplied by the main engine generator set, the engine being a six-cylinder Armstrong-Sulzer airless injection, completely enclosed, traction type, running at 750 r.p.m., with automatic forced feed lubrication to all parts. Safety devices are provided in the oil and water circuits, which shut down the engine in case of failure of supply of either the oil or water. There is also a special engine control device fitted, whereby at a moment's notice the output of the engine may be varied so as to adjust it to suit working at sea level or at an altitude of 2600ft. The starting of the engine is effected electrically. An auxiliary engine generator set, which runs during the operating time of the train, takes all auxiliary loads, thus obviating the use of heavy batteries. Cooling of the water and oil for the main engine is by means of a panel type cooler and electric fan placed on one side of the power unit. Immediately above the auxiliary engine is placed the cooling water tank, and alongside this tank in the roof of the power unit is the fuel service tank. The main fuel tank is placed at the side of the power unit. A rotary exhauster driven by an electric motor for the vacuum brake is placed towards the rear of the power unit.

The main engine is mounted on two longitudinal I beam members with channel cross stiffeners. The power unit bogie is arranged with plate sides and Isothermos axle-boxes and springing is provided by leaf springs. Special attention has been paid to the necessity for light weight, and consequently all the sections have been adopted with a view to securing rigidity with a minimum of weight.



THE GRESLEY ARTICULATED BOGIE ATTACHMENT

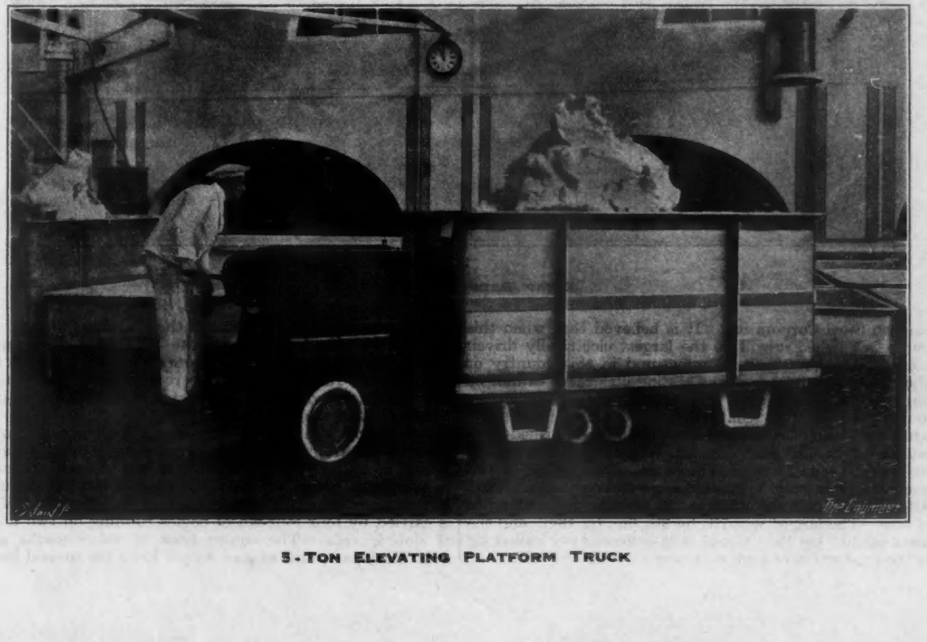
Braking is effected by means of standard clasp brakes on both sides of all four wheels. The axle-suspended motors are carried on shock-absorbing buffers at the nose. The articulated bogies are of special light-weight construction, and the load from the Gresley articulating joint is transferred to the bogie frames through double helical springs by means of a bolster; springing to the axle-boxes is of orthodox form with leaf springs. The bogies under the coaches are also of very light weight and the wheels are braked on both sides.

The main framing of the coaches consists of braced longitudinal girders of all-welded construction. The cross members supporting the coachwork are of light channel section and are bolted to the main longitudinals. The coach bodies are of very light all-metal construction, mounted on the underframes, and are not built integral with the underframes. The body framing consists of pressed steel pillars of U section. The flanges are riveted to the waist rails and cant rails, the flanges being cut away between the inside waist and the cant rails to allow of the windows and louvres being easily removed. The exterior panels are of light sheet steel, riveted to each pillar, and are covered with Carbolostic paint to prevent drumming. All the compartment windows are of the full drop type and are fitted with an inside "Alpax" louvre. Both windows in the driver's compartment are glazed with safety glass and an electric windscreen wiper is fitted to the fixed window in front of the driver. The interior panelling is of plywood covered with leather to the waist line in the first-class compartments and teak finish above, whilst the second-class compartment is painted cream and brown. The total seating capacity is for 100 first-class and 68 second-class, the seats in both classes being of the reversible type. In addition to the three lavatories, a buffet has been arranged, fitted with racks and cupboards and with a small ice chest.

A driving compartment is arranged at each end of the train so as to permit of a shuttle service being run and to obviate the turning of the train set or terminal movements of any description. Control of the train is entirely automatic and is of the Armstrong patented system of voltage control, whereby the full horse-power output of the engine is economically utilised throughout the whole speed range of the train. The complete train weighs 92·6 tons in running order and 103·6 tons loaded with passengers and luggage.

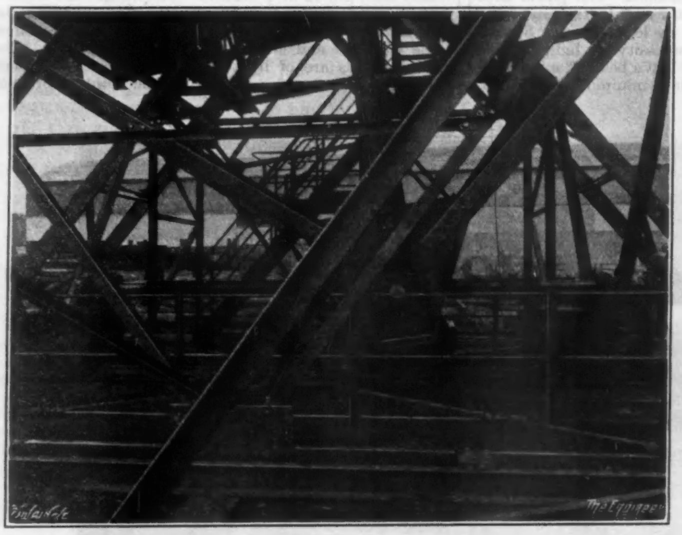
5-Ton Elevating Platform Truck.

THE six-wheel elevating platform truck illustrated has a 5-ton load capacity, and is made by Wingrove and Rogers, Ltd., of Arundel Chambers, Strand, London. The principle of working is well known, but, briefly, goods are loaded on a stillage platform raised 13in. from the floor, and the truck is driven between the stillage legs. The operation of a switch raises the truck platform and stillage 4½in. off the ground in 9 sec., and truck and load are driven away. The elevating motor is tripped automatically at the high and low limits and an electric brake is automatically applied to prevent overruning. The motor can be stopped and reversed at any point desired. The platform is connected to the lifting mechanism by a collapsible link, so arranged that if the truck is accidentally driven into an obstruction, the lifting mechanism is protected. The travelling controller has three speeds in each direction and is interlocked with the brake pedal, so that application of the brake cuts off power. For entering stillage, provision is made for inching on first speed by the use of the brake pedal only. Steering is by tiller moving in a vertical plane operating on all six wheels, giving a

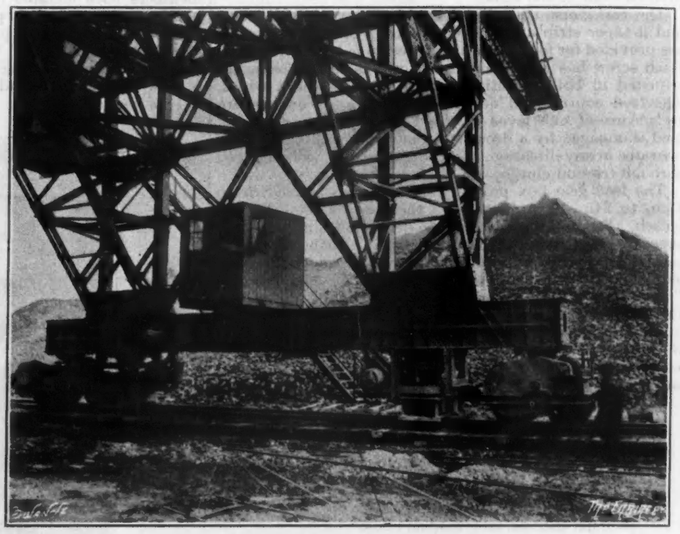


5-TON ELEVATING PLATFORM TRUCK

CANTILEVER CONVEYOR FOR A BRICKFIELD



Gear for Tilting the Conveyor

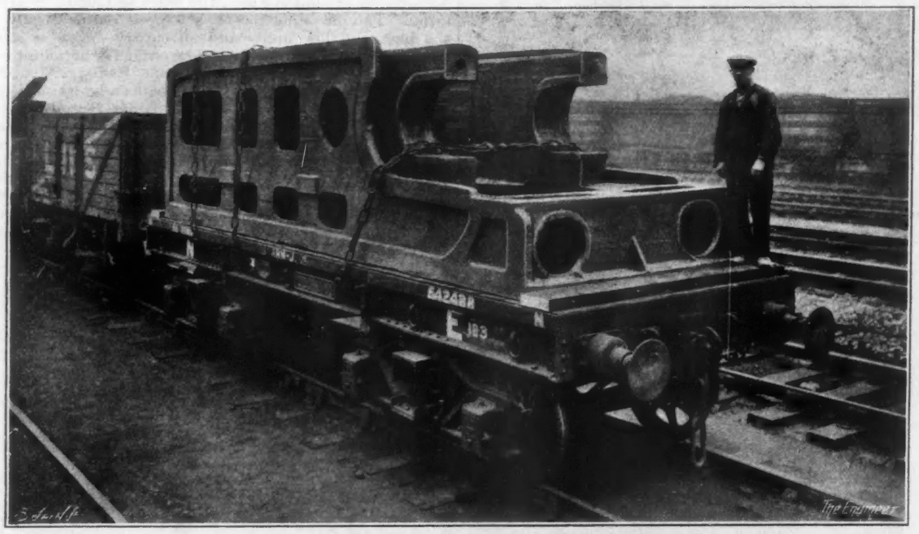


Supporting Bogies and Jacks

turning radius of 6ft. 6in. to the centre of the truck, or, in other words, the truck will turn completely inside a circle of 18ft. diameter. Special attention has been paid to the steering design. Not only is the turning circle claimed to be better than that of trucks of smaller capacity, but owing to the use of stub pin bearings of special design and an adaptation of the maker's "G" type steering principle, the effort required of the driver is even less than that on a 2-ton capacity truck. The four-wheel trailing axle is articulated for traversing uneven ground, and 5in. ground clearance is allowed for passing over the peak of inclined ramps. The driving and elevating motors are of specially light construction having aluminium frames. This lightness is not obtained at the expense of active material or by reducing the air gap, but by the use of laminated split poles of special construction. The motors are capable of withstanding occasional overloads of 300 per cent., and normally work at the one-hour rating. The unladen weight of the truck complete with Edison battery in running order is only 43 cwt.

An Intricate Casting.

In the accompanying illustration is shown one of three castings of similar size recently made by the English Steel Corporation at the Cammell Grimesthorpe steel foundry. These three castings, together, make up the main pump bedplate for the electrically driven hydraulic high-pressure three-throw ram pump, which is being supplied by Vickers-Armstrongs, Ltd., of Elswick, for the 7000-ton press now being installed at the Vickers works of the English Steel Corporation. It is believed that when this pump is finished it will be the largest electrically driven pump of its kind ever manufactured in this country or abroad. The intricacy of the casting illustrated cannot be appreciated at a glance. The difficulties with which the foundrymen had to contend will be better understood when some dimensions are mentioned. The finished casting was 22ft. 6in. long, 7ft. 4in. wide, and 6ft. deep. It weighed 30 tons 12 cwt. Yet its cross ribs and slide bed members were only 1½in., and its walls only 1¾in. thick. Altogether it was necessary to use seventy different types of core. The largest was 7ft. by 3ft. 6in. by 18in., and the smallest 2in. by 1in. Great skill is necessarily called for in the production of such a casting.



Pump Bedplate Casting

A Cantilever Conveyor for a Brickfield.

Recently we had an opportunity of inspecting a conveyor of unusual form which has been designed by the engineers of the London Brick Company and Forders, Ltd., for use at the Stewartby Works of the company, and manufactured for them by Robert Boby, Ltd., of Bury St. Edmund's. It is illustrated herewith and on page 522. The purpose of this conveyor is to remove the overburden of callow from the brick earth deposit and dump it back in the worked-out pit. The actual digging is performed by a Ruston dragline excavator mounted on caterpillar tracks. This machine works on the natural ground level and dumps the callow on to a short conveyor mounted on a bogie, running on rails on the top of the brick earth. This conveyor feeds the main conveyor which is the subject of this article. The object of having this auxiliary conveyor is to obviate moving the main conveyor frequently, and to keep it in touch with the dragline, while it also enables a wider bench to be cleared. At the rear end of the auxiliary conveyor it will be noticed that there is a pan-shaped receptacle into which the contents of the dragline skip are dumped. The bottom of this pan rotates and the callow is scraped off on to the belt conveyor by a plough. In this way the belt is relieved of the impact of the heavy stones falling out of the skip and an even feed is provided. This conveyor is 295ft. long between the centres of the pulleys. It is 48in. wide, and is driven at a speed of 100ft. per minute by a 25 H.P. electric motor.

The business of the main conveyor is, as we have already pointed out, to carry the callow away from the working face and to dump it in the back of the pit. For this purpose it must be able to command the bench, which is some 60ft. above the level of the bottom of the pit on which its substructure runs and also give room for the passage of the 10 cubic yard Ruston excavator that does the actual digging out of the brick earth.

The callow conveyor, which, it will be seen, is cantilevered out from either side of a central tower, has a length of 295ft. over the centres of the end pulleys, and is 48in. wide across the belt. The tower is a substantial lattice work structure surmounted by a pyramid, which is carried by four four-wheel bogies running on two lines of double rails. The centre lines of these tracks are 46ft. 6in. apart, and so give ample room for several lines of service trucks through the portal. The bogies are equipped with motors and gear for travelling the tower at a speed of 43ft. per minute. Between the two bogies, on either side, there are jacking gears, which are used to relieve the wheels from weight when the conveyor is at work. These jacks take the form of a box girder which spans the running rails and is guided in a frame depending from the main girders of the tower. Each of the box girders can be pushed down by a large square-threaded screw and nut driven by its own electric motor. The motors are all controlled from a cabin on the main girder and can be made to keep the tower vertical, regardless of any inequalities in the elevation of the track. The total load which these jacks have to accommodate is some 300 tons, and they are worked by 15 H.P. motors with speed reduction gearing having a ratio of 178 to 1 between the armature shaft and the lifting screw.

At the top of the pyramid on the tower there are two journal bearings which carry the whole weight of the cantilevered conveyor, for it is possible to tilt the conveyor through an angle of 12 deg. above and below horizontal, which gives a latitude of about 40ft. at the end of the conveyor for adaptation to the contour of the bench. The bearings are simple journals, 8in. in diameter by 12in. long, and carry a total load of 103 tons.

Depending from the bottom of the cantilever there is a triangular framework that reaches down to what might be described as the deck level of the tower. At the apex of this triangle there is a slide and crosshead working in conjunction with a horizontal screw that is used to set the angular position of the cantilever. This gear, which is well represented in our engravings, is driven by its own electric motor of 25 H.P. through worm reduction gearing.

The cantilever itself needs little description, as it is a simple structure, 307ft. 6in. long overall, with a maximum width of about 20ft. It is provided with appropriate wind bracing and naturally includes the channels for the conveyor belt rollers.

The belt is 48in. wide and made of six-ply 32-oz. duck, with a $\frac{1}{16}$in. cover of rubber on each side. It was supplied by the British Goodrich Rubber Company, Ltd. The two pulleys at the ends of the cantilever are fixed and the driving and tension gear are arranged at the centre. The tension gear takes the form of a simple fold over three pulleys, on the return side of the belt, of course, from one of which there depends a weight of 8½ cwt. For driving the belt it is taken over two cast iron drums, 39in. in diameter by 50in. face, which are driven through a 20 to 1 David Brown worm reduction gear by a 25 H.P. motor. This gives the belt a speed of 100ft. per minute, and enables it to convey 450 tons of callow per hour. On the carrying side the belt is supported by five-pulley type troughing rolls that run on tapered roller bearings. The bearings are carried on tubular steel spindles, and are arranged for forced lubrication. On the return side the rollers are plain solid-drawn tubes running on tapered roller bearings.

At the feed end of the main conveyor there is superimposed a short length, some 7ft. or so, of feed conveyor, which is driven by gearing from the end pulley of the main conveyor. This comparatively inexpensive belt takes the impact of the feed and thus saves the long main belt from unnecessary damage. At the discharge end the callow is simply dumped off the end on to the ground below.

The electricity supply for the machine is brought in by a trailing cable connected with the mains at a pressure of 400 volts and a periodicity of 50 to the main control cabin just below the deck level, in which there are arranged the necessary transformers and controllers for the several motors.

Finally, we should like to remark that although a brick earth pit is generally associated with mud and discomfort, this machine seems to have been so devised as to keep its working parts habitually clean.

It is announced that at the Fourteenth Exposition of Chemical Industries, which is to be held from December 4th to December 9th in the Grand Central Palace, New York, a novel form of closing the collapsible metal tubes used for such purposes as vending adhesives is to be demonstrated. No details of the principle are yet available.

Heat Liberation and Transmission in Large Steam Generating Plants.*

By E. W. Robey, M.I. Mech. E., and W. F. Harlow, A.M.I. Mech. E.

Steam generation continues to occupy a position of prime importance in industrial processes, and the problem of converting the maximum amount of the potential energy available in various fuels into the heat energy of steam in the cheapest possible manner still demands the closest examination from all angles. In presenting this paper the authors make no pretence of discussing all aspects of a subject which provides material for innumerable papers. Their object, as a result of their experience as practical combustion engineers, is to present certain considerations which have hitherto been somewhat neglected in practice and which seem to indicate that some revision of prevailing ideas is necessary. By a closer observance of certain fundamental principles considered here improvement in existing practice appears possible.

The operation of steam raising resolves itself into two distinctly separate processes, namely :—

(1) The liberation of the heat available in the fuel.

(2) The transmission of the liberated heat to the steam.

These, although proceeding to some extent simultaneously, should be considered independently.

The former process will be considered first, and as the paper is intended to deal principally with the combustion of coals by means of mechanical stokers, the discussion of the first part of the problem will be confined chiefly to the burning of solid fuels by this method.

The Heat Liberation Process.

Although the combustion of coal is a chemical reaction of the most commonplace occurrence, exact information on the manner in which the process takes place and the conditions necessary for the best results was until recent years very incomplete. The demand for larger and more efficient steam-raising units, arising from the development of electric power, led to a much closer examination of the problem, and the results of a large amount of research work are now recorded. At the same time, additional knowledge of certain aspects of the subject is still required and further research into these matters is desirable.

In order to liberate completely the heat available in any fuel it is merely necessary to burn it so that no combustible matter, solid, liquid, or gaseous, is rejected, either with the gaseous products of combustion or with the solid refuse. This, of course, is a simple matter, given unlimited air and unlimited time.

In a boiler plant, however, the fuel must be burnt at a high rate in order to limit the size and cost of the steam-raising equipment, and the operation must be accomplished with the minimum quantity of air with which complete combustion may be obtained, in order to minimise the loss by rejection of heat to the stack. This must be done without causing the formation of any appreciable quantity of smoke. Under these conditions the operation presents more difficulty.

The recognition of these requirements has naturally stimulated the development of firing equipment capable of their fulfilment.

It may be of advantage here to enunciate some axioms which, although perfectly well known, are frequently neglected in practice and in argument. They are as follows :—

(1) The quantity of heat produced from a unit quantity of fuel is unaffected by any increase in the quantity of air over the necessary amount.

(2) The quantity of combustion air governs the amount of flue gas, which is the medium by which far the greater part of the heat is conveyed.

(3) The amount of heat rejected to the atmosphere is, at constant temperature, proportional to the amount of flue gas.

(4) The power required to impel or induce the gases through the heat-absorbing units increases with their mass.

(5) At constant pressure difference any increase in the amount of excess air decreases the fuel-burning capacity of the plant.

Generally speaking, and below certain limits, the smaller the proportion of excess air the greater the difficulty in releasing the total amount of heat available in the fuel, for not only is solid combustible matter liable to be rejected with the furnace refuse, but gaseous combustibles are likely to escape with the products of combustion.

The advantages gained in the efficiency of the heat transmission process due to the use of a small excess of air may result in smoke and may easily be offset or exceeded by the resulting inefficiency of the heat liberation process, due to loss of unburnt combustible matter.

The Development of the Mechanical Stoker.—The difficulties inherent in the hand-fired system with natural draught resulted in the development of the chain-grate stoker, by which means a fuel bed of uniform thickness could be continuously introduced into the furnace without any appreciable influx of uncontrolled air. This was followed by mechanical draught, and the result of this and other developments is the forced draught mechanical stoker, which is to-day perhaps the most widely used equipment for steam-raising purposes. Notwithstanding its general success, however, there is still room for improvement, not so much in the mechanical design of the stoker, as in its manner of application, particularly in the system by which the combustion air and fuel are brought into association.

In the early installations of mechanical stokers with natural draught the machines were set a few feet from the boiler tubes under a refractory arch, the function of which was to ignite the fuel and form a deflecting channel for the volatile gases to direct them into the air stream rising through the rear of the grate.

Comparatively good results were obtained with these arrangements, but to avoid smoke the amount of excess air necessary was considerable and the rate of combustion was limited by the stack draught available. This also limited the thickness of the fuel bed to 4in. or less, for the less the resistance of the fuel bed the greater the quantity of air induced through it by a given draught, and, with a constant CO_2 content, the greater amount of fuel would be burnt.

Notwithstanding the later adoption of mechanical draught, the same type of settings and fuel bed thickness persisted for years. The continued cost of maintaining arches eroded at the higher gas velocities resulted in the evolution of archless settings in which it was found possible to burn many classes of fuel satisfactorily, provided that there was sufficient furnace volume to allow of the diffusion of the leakage air and weak gases into the rich gases from the front of the grate, and to complete combustion in the furnace. Many installations of mechanical stokers are operating in such archless settings at the present time and no difficulty whatever in igniting or burning the fuel to ash is being experienced. This has brought into vogue what has been referred to as the "furnace type" of boiler, in which the height of combustion space above the fuel bed is several times greater than in the case of the original natural draught stokers referred to previously.

In order to prevent smoke when using a minimum of air it has, however, been found necessary with this type of furnace to inject into it, above the grate, a proportion of the combustion air. This secondary air, preferably introduced into the distillation zone at the front of the stoker, thus not only provides oxygen for the early combustion of the volatile gases, but by creating turbulence renders available for combustion the inevitable amount of adventitious air from the rear of the grate.

The subject of secondary air is an important one and merits considerable discussion, as its full significance does not appear to be generally appreciated.

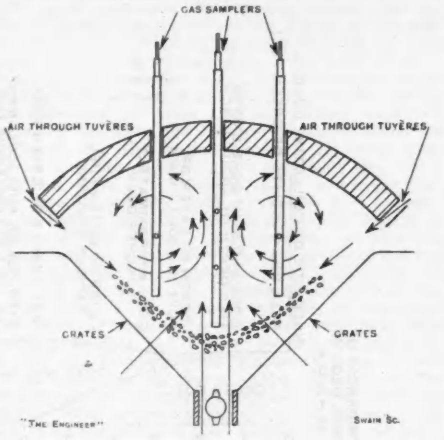


FIG. 1—*Method of Admitting and Sampling Secondary Air.*

The Application of Secondary Air.—Secondary air, mostly induced by natural draught, has been provided for in designs of furnaces at least as far back as 1830, but nevertheless it was, until a few years ago, the exception to find any large externally fired boiler equipped in this manner, and in those cases it was generally inadequate in amount or incorrectly applied. Even to-day much divergence of opinion exists as to its correct application.

In the author's opinion, the advantages of secondary air in large steam generator practice have never been fully explored, because of the mistaken idea that in order to burn coal with a minimum of air it is necessary to pass the bulk of it through the fuel bed, and that secondary air approximating to 10 per cent. in volume is only advantageous for the prevention of smoke from bituminous coals.

In order to appreciate fully the function of the secondary air, it may be helpful to study the manner in which the combustion process takes place, both in the fuel bed and in the space above the fuel bed. The theory appertaining to the use of secondary air is, in a general manner, perfectly well known, but the authors think that the full importance of the subject may be better understood by consideration of the experiments carried out in 1917 by H. Kreisinger, F. K. Ovitz, and C. E. Augustine, as recorded in Technical Paper No. 137 and its companion report, Bulletin No. 135 of the U.S. Bureau of Mines, since these appear to be the most thorough investigations into the process of combustion in and above the fuel bed, that have been recorded.

The first-mentioned deals with the combustion in the fuel bed of hand-fired furnaces, and proves that when bituminous coal or anthracite or coke is being burnt, practically all the oxygen in the air entering the fuel bed from below has disappeared at a level of approximately 4in. above the grate.

The rate of burning varied between 20 lb. and 185 lb. per square foot per hour with fuel beds 6in. or 12in. thick, maintained constant during the experiment. The investigators state that the ratio between the weight of air supplied and the weight of fuel gasified remained constant at about 7/1, so that only about half of the 15 lb. of air required to burn the fuel can be supplied through the fuel bed, and the balance must be supplied above to burn the combustible gas which is present on the surface of the fuel bed to the extent of 20 to 32 per cent. of the total.

Later, in 1922, Audibert carried out experiments to ascertain the effect of leakage air and to find how the gas composition varied when starting with a compact level bed of coke and allowing it to burn away under a constant rate of air supply, until the temperature of the gases began to fall. His grate was 3·3ft. by 1·65ft. built at one end of a horizontal combustion chamber and connected to a flue 30ft. long. The gas samples were taken in such a way as to be representative of the average composition.

He found that the composition of the gases varied with the rate of air supply and this seems to conflict with the conclusions of the U.S. Bureau of Mines. This is probably explained by the fact that his type of experimental furnace allowed of a greater percentage of leakage at high rates of air supply than at lower rates. The interesting fact, however, is that he found that the gases from a 6in. fuel bed contain a large proportion of combustible gas and little oxygen, thus confirming the finding of the U.S. Bureau of Mines.

In a modern chain grate stoker the leakage air forms a far smaller proportion of the total air than in Audibert's furnace, because the grate area is many times larger and the length of the boundaries of the fuel bed does not increase proportionately. Moreover, the design of the modern stoker is such that leakage air is reduced to a minimum. It follows therefore that without secondary air equipment, the only passage for the admission of the air necessary for the complete combustion is through the grate surface. To permit of this, the fuel bed has to be burnt off prematurely and restricted in depth. The disadvantages of this method of operation will be shown later.

The second paper referred to above, namely, Bulletin No. 135 of the U.S. Bureau of Mines, deals with the combustion process in the space above the fire and will now be considered.

The material presented in this report consists principally of the results of about a hundred tests to determine how the gas composition varied in a long combustion chamber fired by a "Murphy" side-feed mechanical stoker, when coals of varying characteristics were burnt. In all these tests, secondary air was admitted at quite a low pressure of 0·1in. to 0·2in. of water through a series of tuyeres extending over the whole length of the fuel admission openings. A section through the grates indicating how the secondary air was admitted, is shown in Fig. 1.

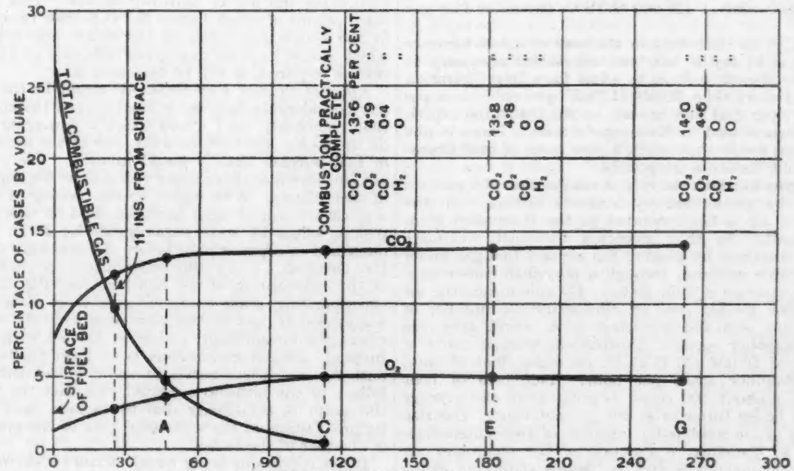


FIG. 2—*Curves Showing Progress of Combustion in Experimental Flue Fitted with Murphy Mechanical Stoker with Secondary Air (U.S. Bureau of Mines).*

Fuel, Pittsburgh screenings ; combustion rate, 35·6 lb. per square foot per hour. All points plotted are the average of not less than six samples taken simultaneously at each section.

The variation of the principal constituents is shown graphically in Fig. 2, which clearly illustrates the combustion process in the space above and beyond the fuel bed. It will be observed that the combustion proceeded at first very rapidly and then at a decreasing rate, until at the section C only 0·4 per cent. of combustible gas remained. Beyond this section the CO_2 content continued to rise and the O_2 content to fall at a slow but definite rate up to the last section at which samples were taken, showing that oxidation and therefore liberation of heat was still taking place. Due to the reduction in the amount of combustible matter it is obvious that no flame would be evident after the gases had passed section C ; in fact, visible evidence of combustion would probably disappear before this point was reached. The fact that slight oxidation was subsequently proceeding, however, indicates definitely that a certain amount of heat was being liberated in the zone beyond the flame. Although this matter was not referred to by the investigators, who consider that to all intents and purposes the process was completed at C, the continued release of heat in this stage of the operation is important when considering the performance of heat-absorbing equipment, as shown hereafter.

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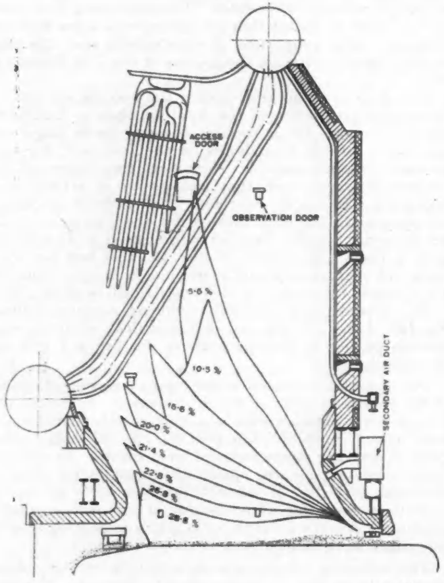
* The Institution of Mechanical Engineers.—Abridged.

In addition to combustible gases, a large proportion of tar and a certain amount of soot was present. At 11in. from the fuel bed the tar and soot had almost disappeared, and beyond this point were completely absent. The methane (CH_4), which is also present at the surface of the fuel bed, quickly disappeared in a similar manner.

The soot, tar, and methane resulted from the distillation of the volatile matter in the coal, and, discussing the combustion of this volatile matter, the investigators reported that "All hydrocarbons are unstable at furnace temperature, and unless enough air to ensure complete combustion is quickly mixed with them at the time they are distilled, they are quickly decomposed, the ultimate product consisting mostly of soot, H_2, and CO. At a distance of 1ft. or 2ft. from the surface of the fuel bed only a very small amount of hydrocarbons can be found in any state, gaseous, liquid, or solid. The persistence of CO in the furnace gases is not due to the difficulty of burning it, but to its constant formation by the reaction between soot and H_2 and CO_2. The cooling surfaces do not cause the formation of soot, they merely collect soot and prevent its combustion." This indicates the necessity of introducing the oxygen as close as possible to the fuel bed.

These investigators, however, seem to have been voices crying in the wilderness, for few boilermakers or operators have up to the present appreciated that secondary air may be used in anything approaching the volumes they indicate, and that it must, to produce the best effect, be impelled into the furnace in such a manner that it reaches those regions from which the combustible gases are rising.



"THE ENGINEER" SWAIN SC.

FIG. 3—*Flame Contour with Varying Percentages of Secondary Air.*

The time required for the air and combustible gases to diffuse together governs the length of the flame.

Rate of Heat Release per Unit Volume.—Referring again to Fig. 2, the authors have calculated the rate of heat liberation in the experimental furnace up to the point C where combustion is practically complete, and find this to be of the order of 120,000 B.Th.U. per cubic foot per hour.

In view of the fact that in the case of many furnaces in operation to-day it has been considered necessary to provide a sufficient volume to allow for a heat liberation rate of not more than 30,000 B.Th.U. per cubic foot per hour, it is clear that they are not as efficient as the experimental furnace used in Kreisinger's tests. There is not the slightest doubt that much higher rates of heat liberation in boiler furnaces are possible.

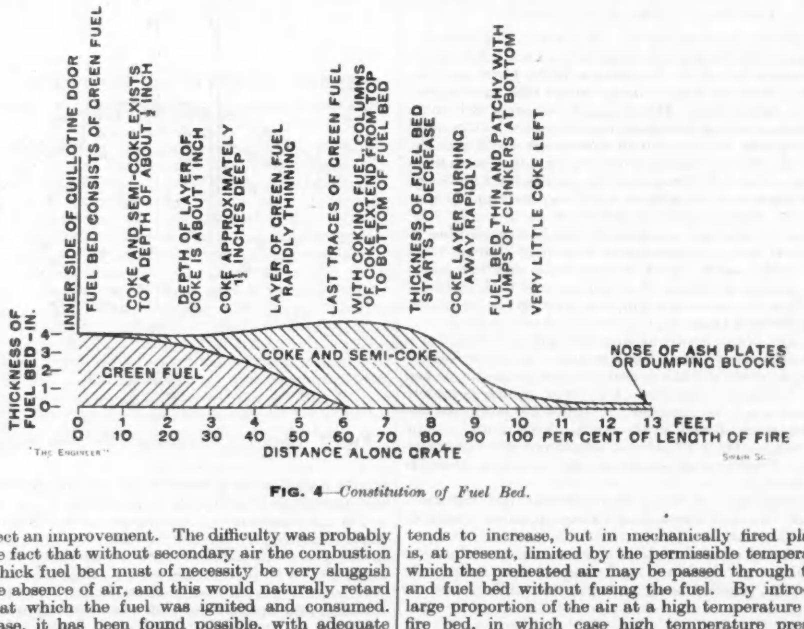
The degree to which the rate of combustion of a gaseous fuel may be accelerated by intimate mixing with the combustion air is demonstrated in the Hammond combustion unit. In this invention extremely intimate mixing is obtained by passing the air and fuel gas under a considerable pressure, through a labyrinth constructed of a large number of thin plates. By this means the air and gas are divided into an almost infinite number of fine streams, and the perfection with which they are diffused together renders possible combustion rates of the order of 20,000,000 B.Th.U. per cubic foot of combustion chamber space per hour. This rate of heat liberation is about 400 times as great as in the average high-duty boiler furnaces at the present time. The size and rating of the combustion chamber of a steam-generating unit is, therefore, a function of the secondary air admission arrangements and the degree of mixing which these arrangements produce.

Notwithstanding the difficulty of drawing oxygen through the fuel bed for combustion of the furnace gases secondary air was, as has been mentioned, seldom employed until the last year or two in large steam generator furnaces. Even so, it cannot be disputed that these installations worked, and are still working, comparatively satisfactorily as regards combustion. Their success depends on the maintenance of a comparatively thin fuel bed, and by burning it off prematurely the requisite secondary air can be obtained through the thinner part of the fire and brought into contact with the combustible gases by means of arches. In these installations, however, smoke is often troublesome, and a long flame, which often extends through the boiler into the superheater, is a feature of their operation. The large furnaces which are now being adopted are the outcome of the experience obtained with such installations.

During the last year the authors have given much attention to the applications of secondary air and find that, given a suitable arrangement, as much as 40 per cent. of the combustion air can be introduced above the fire without using any greater excess of air than was previously necessary; in fact, with installations equipped in this manner it has been possible to operate with a lower margin, as has been indicated by an increase in the CO_2 content up to 16 per cent. at the boiler outlet. This result is possibly due to the decrease in adventitious air due to the lower under-grate pressure necessary to pass the decreased volume against the resistance of the grate and the fuel. It is also found that when this method of operation has been applied to large combustion chambers the upper part is redundant and the flames which, without secondary air, had extended into the boiler passes and beyond, become shortened in the manner shown in Fig. 3, which gives the approximate contour of the flame with varying percentages of secondary air.

The arrangements for admitting the air in this installation are not ideal because of the tendency to project the flame towards the rear wall of the furnace, and to counteract this the authors consider that another row of jets should supply air from the rear and possibly from the sides of the furnace. The effect of injecting the air on all sides would be to create intense turbulence above the fire bed and to prevent the flames from impinging on the furnace walls.

It is generally agreed that in the case of chain grate stokers, as installed a few years ago, in which no secondary air was applied, it was impossible to burn off the coke when a fuel bed thicker than 4in. was used, no matter how much pressure was applied under the grate, and the doubt has been expressed as to whether secondary air would effect an improvement. The difficulty was probably due to the fact that without secondary air the combustion above a thick fuel bed must of necessity be very sluggish due to the absence of air, and this would naturally retard the rate at which the fuel was ignited and consumed. In any case, it has been found possible, with adequate secondary air properly applied, to use fuel beds of a depth more than double that hitherto considered the maximum.



"THE ENGINEER" SWAIN SC.

FIG. 4—*Constitution of Fuel Bed.*

Thus, efficient secondary air admission would appear to render unnecessary the large furnaces used to-day and would permit of much thicker fuel beds than have been previously adopted as a basis of stoker design. Hence, the width of stokers may be proportionately reduced, permitting the use of narrower boilers. This would, in turn, permit of much higher gas velocities being adopted in the convection tubes of the boiler and superheater, which would have an important influence on the heating surface required, as will be discussed later.

Effect of Thicker Fuel Beds.—It might be thought that any considerable increase in the fuel bed thickness above that commonly used would exert a damaging influence on the stoker and furnace walls, due to the increased rate of fuel burning that it would involve. The authors do not consider that there is any real ground for apprehension of such effects. With regard to the heating of the stoker a great amount of light has been shed on this most perplexing effect by some experiments by J. D. Maughan, described in a paper read before the Institute of Fuel by Dr. Grumell. From the observations he has recorded of the constitution of the fuel bed—see Fig. 4—and the corresponding grate temperatures, it is clear that the acquisition of heat by the grate occurs chiefly in the zone where the incandescent fuel is in contact with the grate surface. Similar conclusions have been reached by the authors, and these serve to show quite definitely the fallacy of the hitherto accepted idea that the heating of the grate is principally due to radiant heat from the furnace falling on the uncovered part of the grate surface at the rear of the stoker.

Other conditions being equal, it can be shown that the length of time during which a grate member is in contact with the incandescent coke is the same for any thickness of fire, but obviously the greater the thickness of the fuel bed, the lower is the rate of travel of the grate, from which it follows that the grate members are subject to this condition less often and so keep cooler, as has been found in practice.

Observations have been made of how the temperature of the grate entering the furnace varies with the speed, when operating with a constant fuel consumption, and of the variation in temperature of a grate member throughout the whole cycle, for two different speeds and with constant fuel consumption. From the results obtained it is clear that with a given rate of fuel consumption the grate temperature generally can be reduced by thickening the fuel bed and reducing the speed. By adopting suitable speeds and fire thicknesses, therefore, it appears quite possible to increase greatly the rating of the stoker and to maintain temperatures even lower than are encountered with the relatively thin fires and fast speeds which are at present in general use.

Regarding the effect on the furnace walls, it is admitted that the smaller the furnace the greater will be the intensity of radiant heat falling on a unit area of the wall surfaces. Therefore, an increase in the heat liberation rate certainly increases the severity of the temperature conditions which the walls have to withstand. The modern all-metal water-cooled wall is, however, in the authors' opinion, well able to withstand the conditions that such an increase in the combustion chamber rating would involve.

Apart from the advantages in reducing the size of the furnace described above, the efficient introduction of secondary air, by producing prompt and complete combustion, results in practically complete elimination of smoke. In such plants as can be considered to have an efficient secondary air equipment, the discharge from the stack is invisible. There appears also to be a marked decrease in the amount of grit, which may be due to a lower air velocity through the fuel bed.

Another important advantage gained by introducing a large percentage of the combustion air above the fire, which should not be overlooked, arises from the fact that it is thereby possible to utilise a greater quantity of heat in the combustion air without increasing the temperature of that passing through the grate. Considerations of economy in steam consumption in the modern power plant require that the feed water temperature is raised as high as possible by steam bled from the turbine before it is returned to the boiler unit, and, with advancing boiler pressures, the desirable feed temperature to the economiser rises accordingly. The duty of the air heater in reducing the gases to an economical stack temperature therefore tends to increase, but in mechanically fired plants this is, at present, limited by the permissible temperatures at which the preheated air may be passed through the grate and fuel bed without fusing the fuel. By introducing a large proportion of the air at a high temperature over the fire bed, in which case high temperature presents no objections, and by still limiting the under-grate air temperature to a safe figure, the total heat capacity of the combustion air may be substantially increased.

It appears, therefore, that by the closer observance of the principles of the process of heat liberation expounded above, an advance in the speed of operation may be made, together with a reduction in the size and cost of the stoker and furnace, and arising from this effect, a reduction in the size of the boiler may be contemplated.

(*To be continued.*)

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Steam Plant Accessories, Ltd., inform us that their address now is 59, Palace-street, Victoria-street, Westminster, S.W.1.

Lehmann, Archer and Lane, Ltd., announce that Mr. L. J. Gibson, late director of Peter Stubs, Ltd., has been appointed director and commercial manager.

Mr. H. M. Glass, who until recently was shipbuilding director of Barclay, Curle and Co., Ltd., is now associated with Harland and Wolff, Ltd., with headquarters at their London office, 9, Whitehall, S.W.1.

L. and C. Hardtmuth, lead pencil makers, are building a factory in England. British labour and British material will be used as far as possible, but the leads will continue to be made in Czecho-Slovakia; 80 per cent. of the material and labour will be British.

The Institution of Civil Engineers.—The Council of the Institution of Civil Engineers has awarded the Coopers Hill War Memorial Prize for 1932 to Mr. E. F. Reid, M.A., Assoc. M. Inst. C.E. (Oxford), for his paper on "Failures in Steel and Cast Iron Mains and Provision for their Protection." This prize was founded by the Coopers Hill Society in memory of Coopers Hill men who lost their lives in the war.

Mr. E. H. Wainford.—The death is announced of Mr. E. H. Wainford, who for upwards of thirty years was the North-Eastern representative of Thos. W. Ward, Ltd., Sheffield. A short time ago he relinquished part of his work, and was succeeded at the Middlesbrough office by his son, Mr. A. J. Wainford. Mr. Wainford was seventy-one years of age, and was well known in iron and steel circles in the North of England.

English Steel Corporation, Ltd.—At a board meeting of the English Steel Corporation, Ltd., held in London on November 16th, it was decided to spend approximately an additional £500,000 in continuation of the programme of reorganising and bringing up to date the extensive plant at the Vickers Works, Sheffield. We are informed that the money will be expended chiefly on the drop stamping plant at Sheffield, and on the extension of facilities for the heat-treatment of special steels. Provision is also made for the installation of one further open-hearth furnace in the new steel-melting house, completing a battery of four 60-ton furnaces.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The World's Steel Trade.

The improvement which has taken place in the situation of the British steel industry this year has not extended to foreign steel-producing countries. Whilst the growth of business in British steel materials was long overdue, the general trade position is weakened by the absence of any corresponding movement abroad, as this increases the danger of intensified competition for export orders. A notable feature of the world's situation is the dependence of nearly all steel industries upon their home market, and in many cases upon special Government plans for providing work. The British steel industry seems to be almost alone in its ability to make progress without reliance upon a doubtful policy of public work schemes. During the winter the German steel industry will depend largely upon orders arising from Government programmes, one of which, the enlargement of the Weser-Ems Canal, between the Ruhr and Bremen, will require about 100,000 tons of steel. Of the Continental industries, the French is probably the best employed, but of late there has been a shrinkage in the home demand which the public works programmes have failed to make up. The Belgian industry has probably suffered more than any other owing to its dependence upon export orders. Lately, the position seems to have improved, and the Belgian National Railway is about to issue orders for 200,000 steel sleepers. Nevertheless, the Belgian iron and steel production for the first nine months of 1933 shows an increase of from 6 per cent. to 8 per cent. over the corresponding period of last year The situation in the United States does not progress according to expectations, and production there has only reached 27·1 per cent. of capacity. The Americans also look to the Government for assistance, an instance being the advance of 84 million dollars to the Pennsylvania Railway for the purchase of electric locomotives and rolling stock. Over the steel trades of the world, however, hangs the danger of American competition, which, so far, has been chiefly confined to the lighter branches of the industry.

Current Business.

A FEW weeks before Christmas business in finished iron and steel materials begins to decline in volume, as most of the larger consumers have covered their requirements to the end of the year. Questions of stocktaking and end-of-the-year accounts have much to do with this tendency, which is a well-recognised feature of the trade. The strength of the present demand therefore is an indication of the satisfactory trend of business. Some good contracts have been placed lately, including one by the L.M.S. Railway Company for 2000 12-ton wagons, which have been distributed amongst the British steel works. The Russian Government has placed orders for 5000 tons of steel rails, which have been divided between Colvilles, Ltd., Dorman, Long and Co., and the North-West Coast works. The L.N.E.R. have also placed orders for a shed at Parkeston Quay with the Teesside Bridge and Engineering Company, Ltd., of Middlesbrough, and the G.W.R. have ordered coal-moving machinery from Vickers-Armstrong, Ltd., of Elswick. Glenfield and Kennedy, Ltd., of Kilmarnock, and Sir Wm. Arrol and Co., Ltd., of Glasgow, have secured contracts for the supply of sluice gates and steelwork for the Gebel Aulia Dam in Egypt, to the value of £70,000 and £55,000 respectively. It is understood that the former company will provide steel dam gates, whilst Sir Wm. Arrol and Co. will provide lock gates, capstans and pontoons. The Department of Overseas Trade announces that the following contracts are open for tender:—Argentine State Oilfields Department: rotary air compressor with a capacity for compressing 2000 cubic metres of free air per hour; also the supply of portable arc welding equipment and one grinding machine; to be presented in Buenos Aires by December 4th. South Africa, City of Cape Town: complete filtration plants for swimming baths; to be presented in South Africa by February 8th, 1934. Egyptian Ministry of Public Works: forty iron chains, 14·8 m. long, and thirty-six short link iron chains, varying from 6 m. to 13 m. long; to be presented in Egypt by December 10th. China: a local concern wishes to get into touch with United Kingdom manufacturers of plant for making reconstructed milk and cream. State Electricity Commission, Victoria: supply of control equipment for a 115-kW briquette press motor; to be presented by January 15th, 1934.

Pig Iron.

The position in this market has changed, and consumers are again showing interest in forward contracts. For some weeks past the tendency has been to purchase foundry iron in odd lots as they were required. The firm appearance of the market, however, has influenced sentiment, and it is probable that the caution shown by the producers in starting up new furnaces may also have had an effect upon buyers. On the North-East Coast in particular, although with the two furnaces put into commission last week the number at work is now twenty-one, only three are producing foundry iron. It was anticipated that more furnaces would have been put into operation on Cleveland iron some time ago, but it is reported that the makers are not finding it easy to ensure adequate supplies of furnace coke. It is not surprising, therefore, that consumers are negotiating for contracts up to March, and even beyond, as the stocks in makers' hands are practically exhausted. Most of the sales recently have been to Scottish and local consumers, and the Falkirk foundries appear to be increasing their output, and necessarily their requirements of pig iron. Local consumers are rather sore that the Scottish foundries can buy their iron at 62s. 3d. d/d Falkirk, which is 3d. per ton cheaper, in spite of the transport charges, than d/d Teesside. The Midland producers of foundry iron are also experiencing a good demand, but most of the makers in this district still carry substantial stocks, although these are being drawn upon. In these circumstances consumers are not so anxious to buy far forward; but neither are the producers eager sellers. It is taken for granted that any price movement will be in an upward direction, and this naturally turns the balance in favour of forward contracting when consumers can see their way clear. Scottish producers are not experiencing such satisfactory conditions as are the English; but the demand is steady. The output of the four furnaces making foundry iron is sufficient to meet the requirements of the market, but there is no export buying worth speaking of to help the moderate home demand. Business in basic iron in all districts at the new prices has not been active, as most consumers have contracts they can specify against. The steel works, however, are taking large quantities, chiefly from associated works.

Semi-finished Material.

The production of semi-finished steel is probably the most satisfactory feature of the British steel industry, and large as it is, it barely meets the requirements of the market. In fact, some consumers talk of delays in deliveries, and there is considerable difficulty in placing orders for measurably near delivery. Prices also, in spite of the recent advances, are becoming firmer, and the increase in the rate to £5 5s. for billets has merely strengthened the producers in their demand for premiums. Business can be done at £5 7s. 6d. in a few cases; but the general quotation is £5 10s. Continental works have followed the market up, but they are not offering large quantities for Great Britain. There does not seem much difference now between the prices asked for the British and the foreign material; in fact, some sellers of Continental billets claim they have sold above the British works price. It may be assumed either that these transactions were with consumers who required Thomas basic billets for special purposes, or that they indicate a stringency in some districts more acute than the market suspects. In the Midlands Continental sellers are quoting 2½in. and up at £5 9s., and 2in. and 2¼in. at £5 10s. d/d, including duty; but sellers claim on occasion to have obtained £5 11s. There is no doubt that the Continental makers vary their prices to the conditions ruling in different districts, and it has to be admitted that their policy of collective selling has enabled them to do this with advantage to themselves. For instance, in the Midlands the demand is chiefly for small billets, and their prices for these are higher than in other districts. In Scotland consumers have been quoted £4 17s. 6d. d/d, including duty, for large billets. The demand for sheet bars is not so strong as for billets, nor are prices so firm. At £5 d/d for sheet or tin-plate bars, the South Wales makers keep the local market in their own hands, but in some of the inland districts up to £5 7s. 6d. is asked for British material. The general price, however, is about £5 5s. Comparatively little business finds its way to the Continent, although it is probable that sellers would be prepared to accept £5 d/d, including duty.

The N.E. Coast and the Midlands.

The most important industrial event on the North-East Coast for some time is the restarting of the Acklam Steel Works by Dorman, Long and Co., Ltd. This follows the starting up of two blast-furnaces and two steel furnaces by the same firm, reported last week. The Acklam Works will be engaged upon the production of billets and sheet bars, and it is announced that sufficient orders are in hand to keep the mill employed until the end of the year, the production being about 4000 tons per week. Some fresh rail orders have been booked lately, including a contract for tramway rails for London. A fair number of constructional steel orders have come to hand recently, and although the shipbuilding industry is in a bad position, there has been an increase in the amount of ship-repairing work in hand. There is also a definite expansion of business in the Midlands, and a feature of the industrial revival in this district is the number of new factories being built and the extensions to existing works. This is reflected in a better demand for structural steel and reinforcing bars. There has been a significant movement towards placing contracts for forward delivery, which may be taken as an indication of consumers' fears that the present range of prices for controlled steel materials may be advanced. This is only natural since there has been a definite increase in the prices of re-rolled steel and uncontrolled descriptions. On the other hand, Continental quotations for the British market are higher at £6 17s. 6d. d/d Midlands for joists, as Continental prices have been slightly advanced on Exchange movements. In the case of small steel bars also there is a wide discrepancy between the British and Continental prices. Re-rollers are quoting for the most part £7 5s., and the steel works up to £8 10s., against a Continental figure of £6 10s. 6d. d/d, including duty. Re-rollers outside the district, however, are prepared to fight for a good order, and considering the margin in favour of the Continent, there is not a large tonnage of business going abroad. In South Wales tin-plate sales have not been on such a good scale as recently, and have dropped behind production. Prices have receded to 16s. 6d. to 16s. 9d. f.o.b., 20 by 14 basis. The shadow of American competition on the depreciated dollar has fallen on this trade; but so far there has been no contraction of output at the works.

Scotland, Lancashire, and the North.

Although a certain amount of the Scottish steel makers' plant is unemployed, indications point to a steady if rather gradual expansion. Recent shipbuilding orders will provide an outlet for a moderate tonnage of steel, and further inquiries are in circulation. The industry has also benefited by a large share of the L.M.S. contract for wagons, and about 1500 tons of the Russian order for rails will be manufactured by Colville's, Ltd. There has been talk recently of the help to the steel trade which the resumption of work on the Cunarder would provide; but when work on the vessel was suspended most of the heavy steel material had already been supplied. A fair tonnage of steel in the shape of sheets and other lighter sections, however, would be needed. In the direction of general business, the Scottish steel works are receiving moderate support, but the re-rollers are finding business difficult. Nevertheless, they are keeping their price at £7 5s. for home and £6 15s. for export. Conditions in the Lancashire area are improving slowly, and this applies to the constructional engineers, who, however, are depending upon a multiplicity of somewhat small orders rather than contracts which involve the use of good tonnages of steel. So far, the tendency noticeable in one or two other districts for consumers to place forward contracts for structural steel has not spread to Lancashire. Business in small steel bars has been on an extensive scale, and although many of the Lancashire re-rollers quote £7 10s., business has been done on the basis of £7 5s. Continental competition is not much felt in this market. A few orders have gone abroad recently, but many of the consumers are still able to specify against contracts placed weeks ago with British makers at lower prices than those now ruling. In the Sheffield and Yorkshire district the demand for stainless steel and alloy steel has strengthened, probably because buyers are becoming nervous lest the price advances on some ferro-alloys should force an increase in the prices of the steel in which they are used. The improved prospect of the steel industry in this district is indicated by the decision of the English Steel Corporation to spend £500,000 in improving its Sheffield plant.

A Survey of the Indian Market.

The Department of Overseas Trade has issued a comprehensive report on "Conditions and Prospects of United Kingdom Trade in India" in 1932–33, revised to July, 1933. The price is 3s. 8d. post free, from H.M. Stationery Office. In the section dealing with machinery and iron and steel it is pointed out that the downward movement of the imports of machinery from the high-water mark in 1928–29 has largely been checked. This is satisfactory, as the factors of intense depression in most Indian industries, the curtailment of Government purchases on account of severe financial stringency, and enforced reductions in extensions and renewals by public utility undertakings on the grounds of economy are still operating. Progress on new capital undertakings is also held up owing to the need for the rigid conservation of India's financial resources. The widespread nature of the depression is shown in the heavily reduced imports of boilers, prime movers, electrical machinery, and mining and general industrial plant. On the other hand, the remarkable expansion in the Indian sugar industry which followed the imposition of a high protective tariff has resulted in an advance of nearly £1,000,000 in the value of imports of sugar machinery. Of these imports Great Britain provided 70·2 per cent. in 1931–1932 and 74·1 per cent. in 1932–33, the remainder coming principally from the United States and Germany. The report points out that it is in times of stress such as the present that an efficient organisation on the spot secures such reduced trade as may be offering. In 1931–32 India imported 371,000 tons of iron and steel materials, of which the British share was 44·2 per cent., Belgium being next with 31·8 per cent., and Germany third with 26 per cent. In 1932–33 the total imports were 326,000 tons, of which Great Britain was credited with 43 per cent., Belgium with 31·9 per cent., and Germany with 22 per cent. The report remarks that, in spite of the depreciated sterling exchange, Belgian competition was severely felt in bars, structural sections, hoops and strip, steel sleepers and wire nails, where low price was the primary factor and B.S. specifications not insisted upon. In 1932–33 Luxemburg shipped 17,057 tons of steel bars, whilst Sweden and Norway supplied 1283 tons and 1529 tons respectively of nails, rivets, and washers. The United States was out of the market during the year, but French competition was met with in bars (4841 tons) and structural steel work (2675 tons).

Copper and Tin.

The fluctuations in the dollar exchange have overshadowed the electrolytic copper market and for a time buying by consumers almost ceased. This week, however, a slightly better tone has ruled, and the market recovered from about £32 10s., to which it had dropped, to £33 5s., c.i.f. The American producers continue to hold their domestic price at 8¼c., but buying has been poor. At times the Americans have been anxious sellers and have offered to sell for delivery over the whole of next year at current prices. This attitude marked a change in their policy, as until a few weeks ago they were reluctant to do business in sterling. In the London standard market prices were weak towards the close of last week, but recovered later, and there was a certain amount of covering. The movements of the dollar exchange, however, have been sufficiently erratic to discourage speculation in standard copper. . . . The tin market has shown more resistance to depressing conditions than other non-ferrous metal markets. There has been a fair amount of American buying, but the Continental demand still fails to expand. There is no doubt that the strength of the statistical position has been the principal reason for the firmness of tin prices, and there are expectations that the figures at the end of the month will show a further improvement and a substantial decrease in the visible supply. At the end of last week heavy sales of cash tin reduced the backwardation which had reached 25s., and it is now in the neighbourhood of 2s. 6d.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— *(D/d Teesside Area)*		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
Midlands—		
Staffs.— *(Delivered to Black Country Station)*		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

(Basic iron prices subject to a rebate of 5/-.)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 10 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 15 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/6 to 16/9.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/-
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/-
„ „ „ 1 p.c. carbon	£35 12 6	10/-
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, November 22nd.

Copper—		
Cash	£29 7 6 to £29 8 9	
Three months	£29 10 0 to £29 11 3	
Electrolytic	£32 10 0 to £33 5 0	
Best Selected Ingots, d/d Birmingham	£33 5 0	
Sheets, Hot Rolled	£60 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9¾d.	9¾d.
„ Brazed (basis)	9¾d.	9¾d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	8¾d.	8¾d.
„ Brazed	10¾d.	10¾d.
Tin—		
Cash	£227 7 6 to £227 10 0	
Three months	£227 7 6 to £227 10 0	
Lead:	£11 3 9 to £11 8 9	
Spelter:	£14 8 9 to £14 16 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 13/-
„ Glasgow— Ell	12/6 to 14/3
„ „ Splint	15/9 to 16/-
Ayrshire—	
(f.o.b. Ports)—Steam	12/- to 12/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/6 to 13/9
Unscreened Navigation	12/3 to 13/-
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/6
Secondary Steam	13/-

ENGLAND.

	Inland.	Export.
Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/6 to 20/6
Furnace Coke		13/- to 17/6
Northumberland—		
Blyth Best		13/9 to 14/-
„ Second		12/9 to 13/-
„ Best Small		10/-
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/8
Foundry Coke		17/- to 18/6
Sheffield—		
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	22/- to 24/-	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	6/- to 9/-	—
Nutty Slacks	7/- to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	17/9 to 18/6
Best Steam Smalls	13/6 to 14/-
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 26/-
Foundry Coke	19/- to 36/-
Furnace Coke	16/- to 17/6
Patent Fuel	21/-
Swansea—	
Anthracite Coals:	
Best Large	35/- to 38/6
Machine-made Cobbles	35/- to 48/6
Nuts	37/6 to 48/6
Beans	25/- to 30/-
Peas	18/- to 20/6
Rubbly Culm	10/- to 11/-
Steam Coals:	
Large	18/- to 20/-
Nuts	18/- to 25/-
Smalls	11/- to 13/-

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3¼d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Anglo-French Trade.

The commercial relations between Great Britain and France have been profoundly modified by the system of compensating tax which the French imposed on British goods at the time sterling left gold and before even there could be any definite indication of the effect the depreciation of sterling would have on French manufacturing industries. The sales of British goods in this country had been rendered difficult and in some cases impossible by their much higher prices as compared with those of foreign competitive products. British manufacturers had the reputation of being too dear. The devaluation of sterling did little more than bring down British prices to a level with those of the German, for example, and for the first time British importers saw the possibility of doing business more in harmony with the heavy purchases that were made by Great Britain in France. The compensating tax of 15 per cent. levied on the total cost of British goods imported into France checked this promised expansion of trade. It was also intended to influence Great Britain in stabilising the pound on a gold basis. The immediate effect of the tax was to create a feeling of resentment in Great Britain against what appeared, at the outset, to be a discriminating measure that was contrary to the spirit of the existing treaty of commerce, and all subsequent attempts of the French to negotiate a new commercial treaty have been met by the obligation imposed upon them to suppress the compensating tax. At the time of the London Conference the French Government was disposed to make this concession, and it could not, in fact, logically justify the maintenance of the tax when sterling had settled down to its real level and had shown itself to be the most stable of all currencies. Industrial interests in France, however, opposed the suppression, and commercial interests regarded the removal of the tax as contingent on Great Britain offering compensating advantages; this, too, despite the obvious peril in which it has placed the French exporting industries. British purchases in France have been largely diverted to other channels, while the French are mainly dependent upon Great Britain for supplies of raw material, partly in transit through British ports, and the balance of trade which was considerably in favour of France has now been reversed to her growing disadvantage. People in this country are fully alive to the danger of the situation. Events have of late developed rapidly, and efforts are being made to retrieve the consequences of the various fiscal measures which have had the effect of provoking retaliation from other countries. There has been a lack of method throughout in dealing with the trade situation, and measures have been improvised by various Governments in order to meet more or less temporary conditions. The present Government has taken the matter in hand and is credited with having evolved a plan of organisation which aims, first, at the completion of negotiations that have been continued intermittently with Great Britain since the London Conference. The decision of Great Britain to denounce the agreement with France whereby the two countries undertook to refrain from adopting discriminating tariff measures towards each other is regarded as a serious matter. It is supposed that the British Government contemplates action in view of the refusal of the French to remove the compensating tax. Monsieur Laurent Eynac, Minister of Commerce, was therefore delegated to London this week to discuss the matter with Mr. Runciman. It is difficult to see how such a discussion can be profitable in view of the fact that Great Britain refuses to recognise the principle of the tax, the discriminating character of which is emphasised by its not being applied to the depreciated dollar. There can obviously be no question of Great Britain paying for the suppression of the tax by means of concessions to the French. It may therefore be assumed that Monsieur Laurent Eynac was prepared to discuss difficulties that stand in the way of negotiations for a treaty of commerce under conditions that will be of equal advantage to the two countries.

Free Ports.

The leading port authorities have for many years endeavoured to secure the passing of a Bill for the creation of free zones around them in which factories could be installed for working up materials imported into the zones duty free for export. It was argued that the arrangement would benefit merchant shipping and facilitate export trade, but when the Bill was presented to the Chamber of Deputies last week it was opposed on the ground that the institution of free zones around ports would be a hazardous experiment in present circumstances, for, apart from the huge cost of creating Customs barriers, the freedom granted to foreign shipping would be detrimental to home shipping, which would no longer enjoy a monopoly of the colonial carrying trade, and that, moreover, it would be impossible to suppress frauds. The agricultural interest also opposed the Bill. It was rejected on a preliminary vote without further debate.

Bridge Builders' Responsibility.

Two years ago a suspension bridge at Saint-Denis-de-Pile, in the Gironde, collapsed while being tested under load and several persons lost their lives. The platform broke away from the suspension rods. The bridge was constructed by a firm to the order of the Departmental authorities, and the question of responsibility for the disaster came up for the consideration of the Prefecture of the Gironde, which has now given its judgment, in which it states that the Departmental authorities have some responsibility arising out of the fact that the losses sustained by the public through the accident were the result of work carried out in the public interest; but, on the other hand, the responsibility of the builders only ceased when the bridge had passed the tests and was handed over to the authorities. In these circumstances the authorities and the builders are held jointly responsible for claims for damages arising out of the accident.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

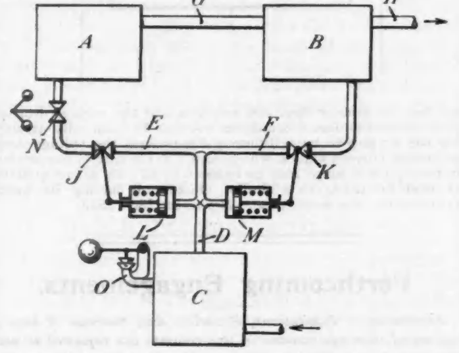
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

399,755. May 24th, 1933.—Steam Power Installations, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

Steam is required at a high pressure in the apparatus A and at a lower pressure by B. It is supplied by the generator C through the main pipe D and branch pipes E and F. Steam from the high-pressure set A exhausts through the pipe G to B and finally at H. Valves J and K are arranged in the pipes E and F, and are actuated by pistons L and M. These pistons work against springs that are so calibrated that A takes steam alone up to a predetermined pressure, but if the pressure in the generator should rise higher, on account of the closing of the governor N, steam will go to the low-pressure unit B *viâ* F. In this way the safety valve O is prevented from lifting with a drop in the load.—*October 12th*, 1933.

Nº 399,755

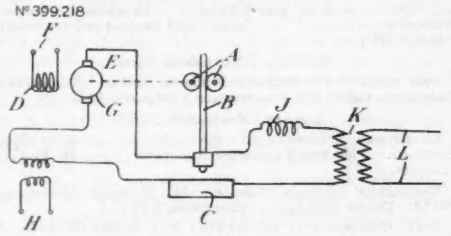


DYNAMOS AND MOTORS.

399,218. April 1st, 1932.—Systems of Electric Motor Control, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

The improved system of motor control described in this specification is particularly suited for controlling the motor employed for operating the feeding mechanism of an automatic arc welding machine. The feed mechanism comprises rolls A arranged to feed the electrode B towards the work C. It is assumed that the stator D of the motor E is fed from supply conductors F at a fixed voltage. The rotor G is fed by a variable tension resulting from the vector component of the tension at the terminals of the arc, and a tension supplied by the secondary of a small auxiliary transformer H, the primary of which is also fed by the network. The arc circuit includes a reactance J and the secondary of a supply transformer K fed from the supply L. By means of a suitable selection of the various constants, the stator and rotor currents are in quadrature for a certain value of the tension at the terminals of the arc. The couple is then nil at the tension which corresponds to a particular length of the arc. It is evident that numerous variations are practicable, especially if the tension of the feed to the stator is obtained, for instance, from another phase than that which feeds the arc.—*October 2nd*, 1933.

Nº 399,218

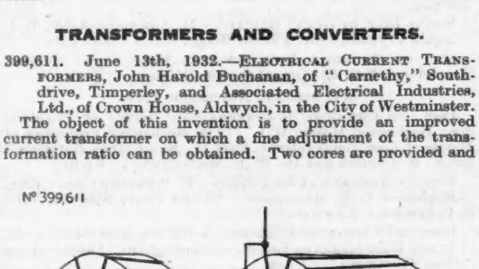


TRANSFORMERS AND CONVERTERS.

399,611. June 13th, 1932.—Electrical Current Transformers, John Harold Buchanan, of "Carnethy," South-drive, Timperley, and Associated Electrical Industries, Ltd., of Crown House, Aldwych, in the City of Westminster.

The object of this invention is to provide an improved current transformer on which a fine adjustment of the transformation ratio can be obtained. Two cores are provided and interlinked with a common primary circuit, which may comprise a single primary winding or separate primary windings connected in series with each other, and a secondary winding on one core is connected serially with a secondary winding on the other core directly, *i.e.*, without the inclusion of any additional impedance, across a tertiary winding on one of the cores. By the direct connection of the windings as described, a fixed relation between the fluxes in the cores on the one hand, and a fixed division of current between the tertiary winding and the secondary windings on the other hand, are assured. The serially connected secondary windings may be connected additively or otherwise. With this arrangement, while a coarse adjustment of the transformation ratio of the transformer can be made by varying the number of turns of the secondary winding on either or both of the cores, a relatively finer adjustment of the transformation ratio can be effected by varying the number of turns of the tertiary winding across which the serially related secondary winding on the respective cores are connected. Preferably the arrangement is designed so that the cores remain unsaturated within the normal working range of current loading of the transformer. In this manner, both cores are fully utilised under all working conditions of current loading, so that the effect is secured of a determinate mean permeability at all loads in spite of the fact that the two cores may have permeability curves differing from one another. The cores may be constructed of materials which differ in respect of their magnetic permeabilities for a given range of magnetising force.—*October 12th*, 1933.

Nº 399,611

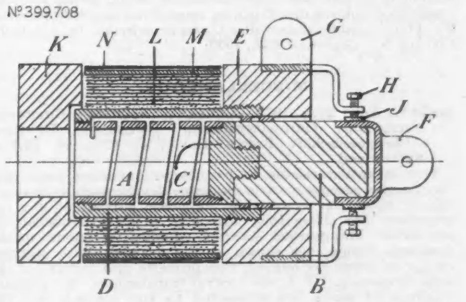


FURNACES.

399,708. February 18th, 1933.—Electrical Resistance Furnaces, Société Anonyme des Manufactures des Glaces et Produits Chimiques de St.-Gobain, Chauny and Cirey, of 1 bis Place des Saussaies, Paris, France.

In the existing resistance furnaces the resistance is secured at both ends in members connected to the poles of the source of electrical energy, with the result that the stresses due to the expansion of the resistance act on the turns of the helix and frequently cause them to fracture. The objects of the invention are to remedy this inconvenience and to strengthen the resistance. The invention provides a resistance comprising two closely spaced coaxial graphite heating elements, one of which is tubular or prismatic, and the other helical. In the drawing, A is the shaped resistance, screwed at one end into a terminal block B by means of a plug C and, at the other end, into the interior of a tube D, which is coaxial with the resistance and is itself screwed into a terminal sleeve E. The resistance A, tube D, and plug C are of graphite. The members B and E are of amorphous carbon and carry metallic current leads F and G. The relative spacing of the resistance A and block B on the one hand, and of the tube D and sleeve E on the other, is adjusted by means of movable screws H engaging in lugs secured to the member E, the screws bearing against insulating members J. The furnace is completed by means of a ring K connected to the sleeve E by means of tie rods (not shown). The space between the ring K and sleeve E is occupied by heat-insulating material L retained by an insulating shell M and a metal sheath N.—*October 12th*, 1933.

Nº 399,708

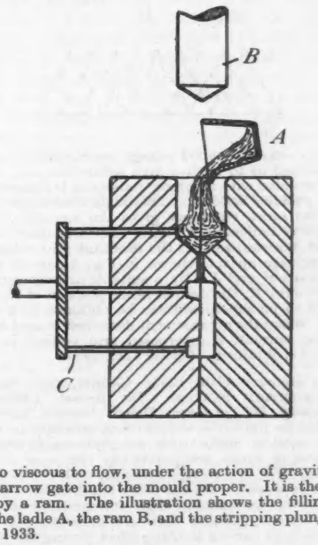


MACHINE TOOLS AND SHOP APPLIANCES.

399,389. February 24th, 1933.—Die Casting, G. J. Weissenberg, No. 11, Tegastrasse, Berlin-Mariendorf, Germany.

This invention is concerned with the die casting of articles in metals having a comparatively high melting temperature. The metal is poured into a head in the mould at such a temperature that it is too viscous to flow, under the action of gravity alone, through a narrow gate into the mould proper. It is then forced into place by a ram. The illustration shows the filling of the head from the ladle A, the ram B, and the stripping plungers C.—*October 5th*, 1933.

Nº 399,389

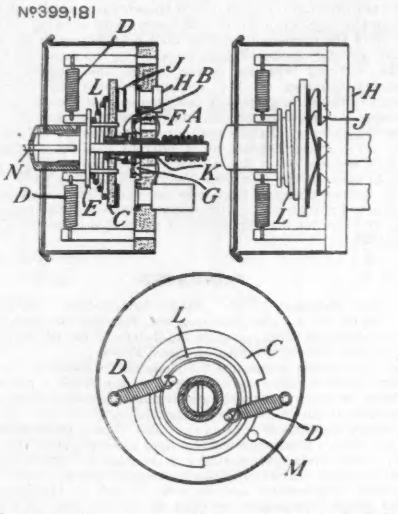


MOTOR CARS AND ROAD TRAFFIC.

399,181. March 29th, 1932.—Electric Circuit Breakers, Joseph Lucas, Ltd., of Great King-street, Birmingham; and Ernest Owen Turner, of the same address.

The object of this invention is to provide an improved automatic circuit breaker adapted for use more particularly in the electrical equipments of motor vehicles, the device being of the type in which the automatic opening of the switch under abnormal conditions is dependent upon the fusion of a metal bond. In the event of an excessive current passing through the heating coil A the heat generated is sufficient to melt the fusible metal bond B. The movable disc C can then return automatically to the "off" position under the action of the springs D acting on the operating member E, the control plate F remaining held by the retaining projections G. After interruption of the current the coil quickly cools and the fusible metal solidifies, thereby re-establishing the bond between the control plate and the rotatable switch member and enabling the switch to be operated again in the normal manner. The fixed contacts are shown at H and the movable contacts at J. The part K is secured to the control plate F formed with a pair of equidistant holes, any opposite pair of which can engage the rounded projections G on the base under the action of the spring L. The extent to which the disc C can be rotated is limited by the stop M. The rotatable contact disc C can be actuated by a detachable key N.—*September 29th*, 1933.

No 399,181

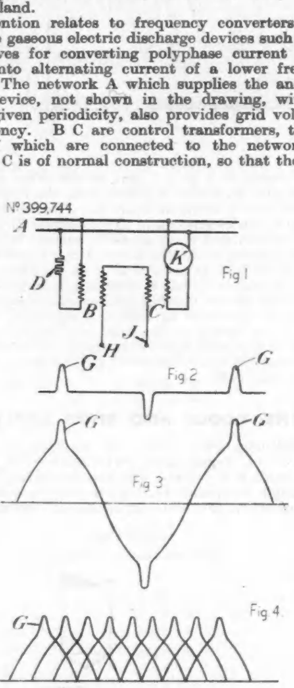


MISCELLANEOUS.

399,744. April 28th, 1933.—CURRENT FREQUENCY CHANGERS EMPLOYING GRID-CONTROLLED DISCHARGE DEVICES, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

This invention relates to frequency converters employing low-pressure gaseous electric discharge devices such as mercury vapour valves for converting polyphase current of a given frequency into alternating current of a lower frequency, or *vice versâ*. The network A which supplies the anodes of the discharge device, not shown in the drawing, with working voltage of given periodicity, also provides grid voltage of the same frequency. B C are control transformers, the primary windings of which are connected to the network A. The transformer C is of normal construction, so that the secondary winding gives a sine-shaped voltage curve, while the transformer B is so wound as to receive high saturation and, at the same time, is provided with an ohmic resistance D connected in series with the primary winding. This highly saturated transformer B with the series resistance gives the secondary voltage the form of curve indicated in Fig. 2. The secondary windings are connected in series, so that the resultant grid voltage with the pointed voltage apex G shown in Fig. 3 can be taken off at the terminals H and J. By a suitable arrangement such as a phase advancer K, the desired phase position of the two curves which are to be superposed can be obtained in a very simple manner. When the arrangement described is used for six-phase alternating current, a superposed grid voltage in accordance with Fig. 4 is obtained.—*October 12th*, 1933.

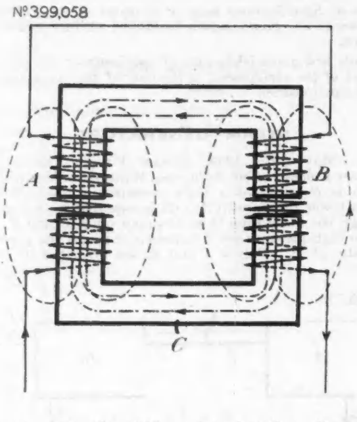
No 399,744



399,058. January 17th, 1933.—CHOKE COILS FOR ELECTRIC DISTRIBUTION SYSTEMS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

In order to limit the short-circuit currents in high-tension systems, coreless choke coils are commonly used, the self-inductances of which are practically the same at all current intensities. For low-voltage systems, such choke coils become large and expensive. On the other hand, choke coils with iron cores have an undesirably high voltage drop when carrying normal currents, because their self-inductance is determined by the required current-limiting effect during the short circuit, and the self-inductance for normal currents increases to a multiple of that for short-circuit currents, owing to the lower iron saturation. The object of the invention is to remove these disadvantages. Two coils A and B are arranged on different limbs of an iron core C, and are connected in series in opposite sense. In the iron core within each coil there is an air gap which is dimensioned according to the conditions, and can also be adjustably arranged by displacing one of the yokes. The operating current may be assumed to flow through the coils at a certain moment in the directions indicated by the arrows, and when the current is normal there is a resultant field in the iron due to the two coils which, as the coils are connected in opposite sense, is only slightly different from zero. Since the leakage is also small in the case of normal current, the resulting self-inductance of the choke coil, measured at the terminals, and thus the inductive potential drop, is only small. If the current increases the leakage also increases, and finally becomes so great in the case of currents of short-circuit nature that the two coils may be regarded as individual or separate choke coils. Their effect is then practically the same as if they were separate and connected in series. The following data have been obtained by experiment:—A choke coil with coils connected in the same sense, and which limits the short-circuit currents at 220 volts to 500 ampères, shows at a normal current of 10 ampères a voltage drop of more than 20 volts. If the two coils, however, are connected in opposite sense, the short-circuit current does not become greater than 500 ampères, but the voltage drop at normal current does not amount even to 10 volts. By arranging the air gap to have different dimensions, the voltage drop at normal current values, which occurs in the case of connection in the opposite sense, may be reduced to as little as one-quarter of that occurring in a similar choke coil having its parts connected in the same sense.—*September 28th*, 1933.

No 399,058



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—Armstrong College, Newcastle-upon-Tyne. "Precision Alternating-current Measurements," Mr. M. Waters. 7.15 p.m.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES.—At James Watt Memorial Inst., Birmingham. "Designing for Welding," Mr. C. Helsby. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Refrigerating Machines and their Applications," Mr. W. S. Douglas. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—At Engineers' Club, Manchester. "The Technique of Heavy Forging," Capt. R. Benson. 7.15 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Liquid Crystals," Sir William Bragg, F.R.S. 9 p.m.

SOC. OF CHEMICAL INDUSTRY: FOOD GROUP.—At British Medical Assoc., Tavistock-square, W.C.1. Symposium, "Bread and Milk." 10 a.m. and 2.30 p.m. Trocadero Restaurant, Shaftesbury-avenue, W.1. Dinner and cabaret entertainment. 7.15 for 7.30 p.m.

SATURDAY, NOVEMBER 25TH.

INST. OF CIVIL ENGINEERS.—Students' visit to Erith works of Callender's Cable and Construction Company, Ltd.

MONDAY, NOVEMBER 27TH.

BRADFORD ENGINEERING SOC.—At Technical College, Bradford. "Modern Pyrometer Apparatus," Mr. H. Pickard. 7.30 p.m.

ENGINEERS' GERMAN CIRCLE.—At Holborn Restaurant, W.C.1. Dinner and dance. Reception, 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—At Armstrong College, Newcastle-upon-Tyne. "Application of Automatic Voltage and Switch Control to Electrical Distribution Systems," Messrs. W. Kidd and J. L. Carr. 7 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. Cantor Lecture, "Colour Block Prints," Lecture II., Mr. Hesketh Hubbard. 8 p.m.

TUESDAY, NOVEMBER 28TH.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Grosvenor Restaurant, Gordon-street, Glasgow, C.2. Annual dinner and ladies' evening. 6.30 p.m. for 7 p.m.

INST. OF PRODUCTION ENGINEERS: YORKSHIRE SECTION.—Hotel Metropole, Leeds. Discussion on "Estimating Methods." 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Liquid Crystals," Sir William Bragg, F.R.S. 5.15 p.m.

SOC. OF CHEMICAL INDUSTRY.—At Hotel Great Central, Marylebone, N.W.1. Annual chemical dinner.

WEDNESDAY, NOVEMBER 29TH.

INST. OF CHEMICAL ENGINEERS.—In Rooms of Chemical Soc., Burlington House, W.1. "The Mechanical Properties of Metals at Low Temperatures, Part II., Non-ferrous Materials," Mr. E. W. Colbeck and Dr. W. E. MacGillivray. 6 p.m.

INST. OF MECHANICAL ENGINEERS: N. WESTERN GRADUATES.—Engineers' Club, Manchester. "Tidal Power Schemes," Mr. J. L. Morden. 7.15 p.m.

INST. OF PRODUCTION ENGINEERS: BIRMINGHAM GRADUATES.—James Watt Memorial Institute, Birmingham. Discussion on "Heat Treatment." 7 p.m.

THURSDAY, NOVEMBER 30TH.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOC.—Hotel Metropole, Leeds. Short paper by students for discussion. "Tramway Reconstruction," Mr. C. R. Warman: "An Economic Aspect of Reinforced Concrete," Mr. E. A. Dyer. 7.30 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Informal meeting. Mr. O. Bulleid will open discussion on "The Most Suitable Form of Traction for Main Line Railway Operation." 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—In James Watt Memorial Inst., Birmingham. "Symposium on Defects in Cold Working," arranged by Mr. A. L. Molineaux. 7 p.m.

FRIDAY, DECEMBER 1ST.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Thomas Lowe Gray Lecture, "High-speed Diesel Engines for Marine Service," Mr. H. R. Ricardo, F.R.S. 6 p.m.

INST. OF SANITARY ENGINEERS.—At Abercorn Rooms, Great Eastern Hotel, Liverpool-street, E.C.2. Annual dinner. 6.45 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Dairy Machinery and Plant," Mr. W. Chopping. 7.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS.—In Mining Inst., Newcastle-upon-Tyne. "The Electric Welded Ship 'Peter G. Campbell,'" Mr. N. M. Hunter. 6.p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1.—Discourse by Mr. R. M. Chambers. 9 p.m.

SATURDAY, DECEMBER 2ND.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—Joint visit with graduates of N.E. Coast Inst. of Engineers and Shipbuilders to the Pelaw Main Collieries coal-washing plant at Wrekenton.

STEPHENSON LOCOMOTIVE SOC. (MIDLANDS).—At Crumpsall Library, Manchester. "The Liverpool Overhead Railway. 6.30 p.m.

MONDAY, DECEMBER 4TH, TO FRIDAY, DECEMBER 8TH.

SMITHFIELD CLUB SHOW.—At Royal Agricultural Hall, Islington, N.1. 9 a.m. daily.

MONDAY, DECEMBER 4TH.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Rendezvous Restaurant, Pilgrim-street, Newcastle-upon-Tyne. Informal meeting. Discussion, "Electricity as a Heating and Warming Agent," opener Mr. L. E. Mold. 7 p.m.

SOC. OF CHEMICAL INDUSTRY.—Burlington House, W.1. "The Control and Measurement of the Temperature in an Industrial Laboratory," Messrs. E. A. Cooke and J. C. Swallow. 8 p.m.

TUESDAY, DECEMBER 5TH.

CHADWICK PUBLIC LECTURES.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Rural Sanitation," Mr. J. H. Coste. 8 p.m.

CHELSEA POLYTECHNIC.—Manresa-road, S.W.3. Distribution of prizes, diplomas, and certificates to students by the Viscount Leverhulme. 8.30 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At N. British Station Hotel, Edinburgh. Dinner, 6.30 for 6.45. Prof. F. G. Baily will introduce a talk, "Reminiscences of Early Days."

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Shipyard Methods and Lay-outs," Mr. G. Barrie. 7.30 p.m.

WEDNESDAY, DECEMBER 6TH.

INST. OF MECHANICAL ENGINEERS: N. WESTERN BRANCH.—(Joint meeting with the Liverpool Engineering Soc., Liverpool.) Thomas Lowe Gray Lecture, "High-speed Diesel Engines for Marine Service," Mr. H. R. Ricardo, F.R.S. 7.15 p.m.

THURSDAY, DECEMBER 7TH.

INST. OF MECHANICAL ENGINEERS: N. WESTERN.—Engineers' Club, Manchester. "Factors Affecting the Grip of Force, Shrink and Expansion Fits," Mr. R. Russell. 7.15 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Properties of Concrete—A Summary of Present-day Information," Mr. J. Singleton-Green. 7 p.m.

FRIDAY, DECEMBER 8TH.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND STUDENTS.—Boots' Café, Colmore-row, Birmingham. Annual dance.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Discussion, introduced by Mr. A. Perry-Keene, "Shop Organisation." 7 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Signalling, Remote Control," Mr. Edward Wallis. 7.30 p.m.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

VICKERS-ARMSTRONGS, Ltd., Elswick Works, Newcastle-on-Tyne, have received a further order from the Great Western Railway Company for equipping ten hydraulic coal hoists in South Wales ports with the "Norfolk" spade for the quick clearing of small coal from railway wagons.

THE L.M.S. RAILWAY COMPANY announces the placing of orders for the construction of 2000 new freight wagons on renewal account, in order to provide for the extension of the company's policy of running an increased number of express freight trains. All these wagons will be of the 12-tons open type for conveying general merchandise, and will be fitted with the continuous brake to enable them to be used in high-speed freight trains. Four hundred of them will be built in the company's own workshops, and the remainder have been ordered in equal proportions from the following firms:—Birmingham Railway Carriage and Wagon Company, Ltd.; Metropolitan Cammell Carriage Wagon and Finance Company, Ltd.; Charles Roberts and Co., Ltd., Horbury Junction (Yorkshire); Hurst Nelson and Co., Ltd., Glasgow. An important feature of the new wagons is that they will be fitted with underframes constructed wholly of British steel.

THE ENGLISH ELECTRIC COMPANY has received a contract from the Leeds Corporation covering switchgear and transformers for the Whingate sub-station, comprising a 24-panel, 6600-volt, metal-clad switchboard of 350,000 kVA rupturing capacity, and four 6000-kVA, three-phase power transformers, with remote-controlled on-load tap-changing gear. In addition, the contract covers a number of 11-kV oil-immersed isolators, a four-pillar metal-clad switchboard with neutral earthing, a cubicle type control board, and auxiliary apparatus, such as battery, battery board, motor generator set, oil filtering plant, &c. The value of this contract is in the neighbourhood of £34,000. The same company has received an order from the Kettering Urban District Council for 33,000-volt and 11,000-volt switchgear necessary for the new station giving the electric supply to the New Mill of Stewarts and Lloyds at Corby. This contract includes a 33,000-volt outdoor type sub-station controlling transformer and feeders with switchgear of 500,000-kVA rupturing capacity, remote controlled, together with structures, foundation work, fencing, flood lighting, &c.; and a 7-unit, 11,000-volt metal-clad switchboard, having a rupturing capacity of 250,000 kVA, together with auxiliary switchgear for lighting and heating, &c. In parallel with the order for Kettering Urban District Council, the company has also received a contract from Stewarts and Lloyds, Ltd., for the 11,000-volt metal-clad switchgear required for the New Mill at Corby. This contract covers some thirty-five units in all for installation in seven sub-stations. This gear will have a rupturing capacity of 250,000 kVA. Stewarts and Lloyds, Ltd., have also awarded the English Electric Company a contract for sixteen transformer units. The value of the latter three contracts is approximately £33,000.

L.N.E.R. MAIN LINE OIL-ELECTRIC LOCOMOTIVE.—We are asked to state that the rotary exhauster for the above-named locomotive described in our issue of November 17th, was supplied through the Consolidated Brake Company and was manufactured by Reavell and Co., Ltd., Ipswich.

A Seven-Day Journal

The Value of Naval Work.

IN the course of a speech made at the annual general meeting of the Fairfield Shipbuilding and Engineering Company, Ltd., held at Govan, Glasgow, on Friday last, November 24th, Sir Alexander Kennedy, the chairman and managing director of the company, said that in view of the long-continued and severe depression, the company had every reason to be satisfied with the result of the year's working, which had enabled a small credit balance to be carried forward. Sir Alexander referred to the naval work which had been entrusted to the company by the Admiralty, and commented on the definite improvement in the outlook with regard to merchant shipbuilding. He stressed, however, the importance of Admiralty work, which, he said, might best be appreciated when one remembered that one cruiser of, say, 9000 tons displacement, was at least equal in value to twenty vessels of about 8000 tons deadweight carrying capacity, and that at least 85 per cent. of the cost of such a vessl was spent in wages. The Admiralty had done a good deal in the last few years to assist the shipbuilding industry, and he felt that more would have been done but for Government restrictions. An adequate Navy was essential for the defence of this country and the Dominions, but there was another point which he thought should weigh with the Government. In times of merchant shipbuilding depression, naval programmes should, he held, be anticipated in order to advance technical skill and maintain skilled workmen in regular employment. Our high position in industry depended on the skill of our craftsmen, and skill acquired by continued application would render an invaluable aid to industrial development.

A New Grid Tariff.

THE Central Electricity Board has notified authorised undertakers in the North-West England and North Wales area of the introduction of a "grid" tariff to become operative on January 1st, 1934. Particulars of the tariff for the South-East England and East England areas were given in our issue of November 3rd, and it will suffice to call attention to the figures, which differ from those in that tariff. As regards the service charge there is no change, but the fixed kilowatt charges in respect of each point of supply are £3 7s. 6d., £3 3s., £2 18s. 6d., and £2 14s., the progressive reduction of the kilowatt charge being made as the demand of an undertaking increases in the manner now familiar to supply engineers. There is no change in respect of variations of the fixed charge with power factor. The paragraph covering the variation governed by rates shows that the fixed kilowatt charge is increased or reduced at the rate of 1s. 10d. for each shilling above or below 4s. arrived at by the usual method. For each kilowatt supplied and taken during the year the sum of 0·2d. is to be paid, and if the usual coal cost calculation gives a sum of more or less than 15s., the running charge will be increased or reduced in the year by 0·0009d. for each penny by which the sum is above or below 15s., As before, a halfpenny or any greater part of a penny is treated as a penny, whilst in the case of the rates variation of the fixed charge a *pro rata* increase or reduction is made for any part of one shilling.

A London Trollybus Scheme.

THE London Passenger Transport Board announces that during the present session of Parliament it will promote a Bill for the conversion of certain tramway routes in London to trollybus operation. The proposed routes represent about one-quarter of the total miles of tramway track in London, and will increase the present 18 miles of trollybus traction by some 90 miles. Most of the routes chosen for conversion are in the outer areas and they comprise the route from Hammersmith to Hounslow and Uxbridge, Hanwell to Brentford, Acton to Canons Park and Paddington to Sudbury. A new terminus near Tottenham Court-road will be arranged for the trollybus services from Euston to the northern areas, while the southern routes will include those from Woolwich to Dartford, Woolwich to Bexley Heath, and the Crystal Palace to Sutton. The latest type of trollybus will be employed, with a seating capacity of seventy-four, compared with sixty-four for the latest type of tramway vehicles. No decision has been announced with regard to the disposal of the discarded tramway vehicles, but it is felt by the Board that a large number of them are definitely nearing the end of their useful lives.

New Shipbuilding Orders.

THE month of November has seen important additions made to the order books of British shipbuilding firms, and within the past week a number of new orders have to be recorded. The Admiralty has entrusted to the Fairfield Shipbuilding and Engineering Company, Ltd., the building and equipping of the coastal sloop "Kingfisher," belonging to the 1933 naval programme. At the neighbouring Govan yard of Harland and Wolff, Ltd., construction will shortly be begun on a 515ft., 13,000-ton, 16-knot, refrigerated cargo motor vessel for the Shaw, Savill and Albion Company, Ltd., of London. Two sister ships are being built at the Belfast yard of Harland and Wolff, Ltd. Other Clyde orders include three welded shallow draught motor vessels for Irrawaddy Flotilla service, which are to be built by William Denny and Brothers, Ltd., at Dumbarton. The Anglo-Saxon Petroleum Company, Ltd., of London, has placed orders for twelve large motor tankers, four of which will be built in Great Britain, three in Holland, three in Germany, and one each in Italy and Denmark. They will all be of 12,100 tons deadweight carrying capacity, with a length of about 465ft. and a beam of 60ft., and will each be propelled by a single 4000 B.H.P., eight-cylinder oil engine having cylinders 650 mm. by 1400 mm. Both hulls and machinery will be built to the owner's special specification. The four British orders have been placed with Lithgows, Ltd., of Port Glasgow; Workman, Clark (1928), Ltd., of Belfast; Harland and Wolff, Ltd., of Govan; and Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne. The engines for the Lithgow and Swan Hunter hulls are to be supplied by John G. Kincaid and Co., Ltd., of Port Glasgow, and Hawthorn, Leslie and Co., Ltd., of Newcastle-upon-Tyne, respectively. Orders for three steamers have been placed by Cory Colliers, Limited, of London, with the Wear shipbuilding firm of S. P. Austin and Son, Limited. The engines will be built at Sunderland by the North-Eastern Marine Engineering Co., Ltd.

L.M.S. Locomotive Orders.

CONSIDERABLE satisfaction is felt in the British locomotive industry by the announcement that the London, Midland and Scottish Railway Company has placed with locomotive building firms orders for one hundred locomotives and tenders for express passenger and goods trains. The Vulcan Foundry will build fifty 4-6-0 superheater two-cylinder engines for mixed traffic; and the North British Locomotive Co., Ltd., fifty 4-6-0 superheater three-cylinder engines for passenger traffic. In the case of the Vulcan Foundry about 400 men have recently been employed, and it is anticipated that it will now be possible to find employment for about 1600 additional men, the work occupying about nine months. The Scottish order will likewise bring about an increase in the number of workers employed both at Springburn and in auxiliary trades. Further employment in the railway rolling stock industry has been created at the Motherwell works of Hurst, Nelson and Co., Ltd., which firm has secured part of the order for 2000 12-ton wagons for the London, Midland and Scottish Railway Company, which was briefly referred to in last week's Market Notes on current business.

Rural Water Supplies.

SPEAKING in the House of Commons on Monday evening, November 27th, Sir E. Hilton Young, the Minister of Health, announced that the Chancellor of the Exchequer had agreed to put at his disposal the sum of £1,000,000, which would be used towards the capital cost of water schemes in rural areas to be prepared and initiated in the next few years. A Bill will shortly be introduced in connection with the scheme. It was essential, the Minister continued, that the local authorities and the consumers of water should bear their proportion of the cost, but the Exchequer grant would be used to mitigate the local burden. The provision of Government assistance in that matter was no indication of the weakening of the Government's general policy of abstention from any form of unremunerative schemes. Water schemes, he held, stood on their own basis of merits as essential for the public health. It was estimated that the capital sum of one million pounds, utilised in the way indicated, would help the promotion of schemes and break the back of a very difficult problem. He was confident that the Government's decision would be welcomed as a real contribution to that problem.

Empire Communication.

THE ninth annual Norman Lockyer Lecture was delivered by Professor E. V. Appleton in the hall of the Goldsmiths' Company on Thursday, November 23rd, the subject being Empire Communication. It was no exaggeration to assert, the lecturer explained, that the whole history of communication by both cable and wireless had been stimulated by Imperial requirements. The first two great pioneer achievements in long-distance communication were concerned with the linkage of Great Britain with her oldest Colony, Newfoundland. The commercial short-wave beam stations, which now linked up the Motherland with India and the Dominions, constituted an unparalleled system of efficient and inexpensive point-to-point communication, while the Rugby long-wave telegraph station of the Post Office gave a service of nearly twenty-four hours a day to all parts of the world. During the last few years direct wireless telephone services to different parts of the Empire had been established by the Post Office, the beam senders and directional receivers being used with corresponding stations overseas. The sending stations were all accommodated at Rugby, while the corresponding receiving stations were at Baldock. The result of these Empire services was that the whole of the Empire was on the telephone, with London as the exchange. A man in the Australian bush could communicate with another out on the veldt in South Africa *via* Rugby and London. By way of the Transatlantic route such outlying districts could be linked up with the whole of the United States and Canada. London was the world's switching centre, and Rugby its relay station. An American tourist out in Egypt would speak to his home in Philadelphia, not directly to the United States, but *viâ* the British Egyptian service through Baldock, London and Rugby.

Southern Railway Electrification.

THE Southern Railway, which already has the largest suburban electrified system in the world, has decided to extend its electrified lines to Sevenoaks, Kent. The extension will be from Chislehurst and Orpington and will add 23 route miles to the electric system, at a cost of over £500,000. Needless to say, the third rail direct-current system will be employed. The stations affected are Orpington, Chelsfield, Knockholt, Dunton Green, Sevenoaks (Tubs Hill), St. Mary Cray, Swanley Junction, Eynsford, Shoreham, Otford, and Sevenoaks (Bat and Ball). Trains will consist of eleven three-car motor units and four two-car trailer units. The new electric services will be supplementary to the existing main line trains and the number of trains serving the various stations will be increased to the extent of 86 per cent. to 209 per cent. The service to Sevenoaks (Tubs Hill) *viâ* Swanley will be an extension of the existing service from Holborn Viaduct to Shortlands *viâ* the Catford loop. Three three-car trains will run every hour between Charing Cross and Sevenoaks *viâ* Swanley Junction on weekdays and two trains per hour on Sundays. During the busiest periods the trains between Swanley Junction and London will consist of eight car sets. The service between Sevenoaks and Charing Cross *viâ* Chelsfield will be a continuation of the existing service between Charing Cross and Orpington and will consist of three trains per hour on weekdays and two trains per hour on Sundays. During the rush hours trains between Charing Cross and Orpington will consist of eight-car sets, which will be broken down at Orpington and will continue as three-car sets between that station and Sevenoaks.

Southampton Port Approaches.

FOR some time past the Southampton Harbour Board has been in touch with the Elder Brethren of Trinity House with regard to much-needed aids to the navigation of the approaches to Southampton Harbour, which area, however, falls outside its jurisdiction. On Tuesday afternoon, November 28th, at a meeting of the Harbour Board, a letter was read from the Elder Brethren stating that Trinity House would be prepared to give favourable consideration to a scheme for the establishment of a radio beacon at the Nab Lighthouse, provided that the Harbour Board would make a substantial contribution towards the first cost and maintenance. The first cost is estimated at £2000 and the maintenance at £200 per annum. The Works and Harbour Committee of the Board reported that the radio beacon at the Nab Lighthouse was an absolute necessity and suggested that the range of the beacon should be extended to 30 or 35 miles, so that both entrances to Southampton Water would be served. The Committee recommended the Board to pay a contribution of £1000 towards the cost, but to inform Trinity House that it could not undertake any payment for maintenance. The Board has just spent some £3000 on the improvement of the Fawley beacon.

The French Liner L'Atlantique.

IN a Journal note of September 1st we outlined the difficult problem presented by the burnt-out hull of the liner "L'Atlantique," which her owners had abandoned as useless, and the underwriters had refused to take charge of, except for repairs. In order to get over the difficulty presented, the Seine Commercial Court appointed three experts to re-examine the hull and propelling machinery and to report on the possibility of repairing them and reconditioning the liner. The experts' report was made known on Friday last, November 24th, and it is understood that by a majority of two to one it was decided that the ship could not be repaired. The experts are further of the unanimous opinion that the cost of repairs would exceed in any case the 100 million francs provided by the all-risks policy. If the Court confirms the findings of the experts, then the owners will not only be entitled to recover the 100 million francs above referred to, but also a further 70 million francs covered by the total loss insurance. As the greater part of the insurance was effected, either directly or by reinsurance, with British underwriters, the position is a serious one, both for the underwriter and for the shipbuilder, who might repair the liner. The suggestion that a compromise may be reached between the owners and the underwriters is denied by Monsieur Leopold Dor, who is acting for the Compagnie Sud-Atlantique, who has stated that the law will take its course, and that the case will likely come up for hearing before the end of the year.

Recent Hydro-Electric Power Plants in Sweden.

No. IV.

(Concluded from page 512, November 24th.)

OTHER POWER STATIONS ON THE INDAL RIVER.

SOME brief mention should be made of the utilisation of the waters of the Indal River for the generation of electric energy in two plants which are already in operation. The most important of these is the Hammarforsen dam and hydro-electric plant. The development of the Hammarforsen waterfall on the Indal River began in 1925 and the hydro-electric station commenced operation in 1928. The plant, which is owned by the Hammarforsen Power Company, is the largest of an extended system of interconnected and co-operating generating plants supplying power to a number of important industries in the area between the Angerman River in the north and the Ljusnan and the Hamrange River in the south. Another plant, completed this year, is that at Sillre, on the Oxsjöan, a tributary of the Indal River, where storage plant has been installed by which water is pumped from the Indal River to Lake Oxsjön, 197 m. above it. We hereunder describe this interesting plant.

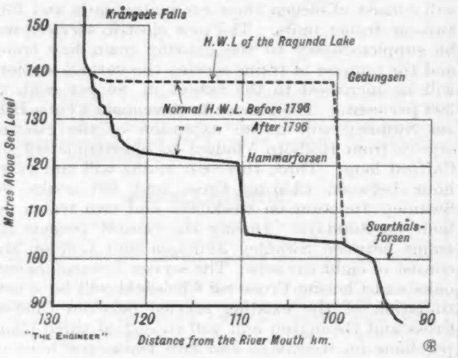


FIG. 31—LONGITUDINAL PROFILE OF THE GEDUNGSEN AND HAMMARFORSEN FALLS

The Hammarforsen is a remarkable waterfall in so far as it is, geologically speaking, the youngest fall in Sweden. Before 1796 there was, at the site of the present falls, a large lake, the Ragunda Lake, which had its outlet through the Gedungsen rapids of about 35 m. height. The water level of the lake then stood about 18 m. above the present water level upstream of Hammarforsen. In 1790 the digging of a small canal, through a ridge of sands and gravels to the right of the Gedungsen rapids, was begun by a logging company, with the object of providing a convenient passage for the timber past the rapids. When the work had advanced so far that the water of the lake began to discharge through the canal, a heavy scour took place in the glacial material of the canal bed during a high flood, and on June 6th, 1796, a catastrophe happened. In a few hours the lake surface was lowered about 35 m. and an immense volume of water flowed down the valley of the Indal River, causing considerable damage. The scouring continued upstream from Gedungsen, but about the middle of the old Ragunda Lake the waters passed over a ledge of rock, which traverses the valley at right angles to the direction of the stream, forming a new waterfall, the Hammarforsen. At the place where the great Gedungsen fall once foamed there is now only the "Dead Fall" to remind one of the catastrophe (Fig. 31).

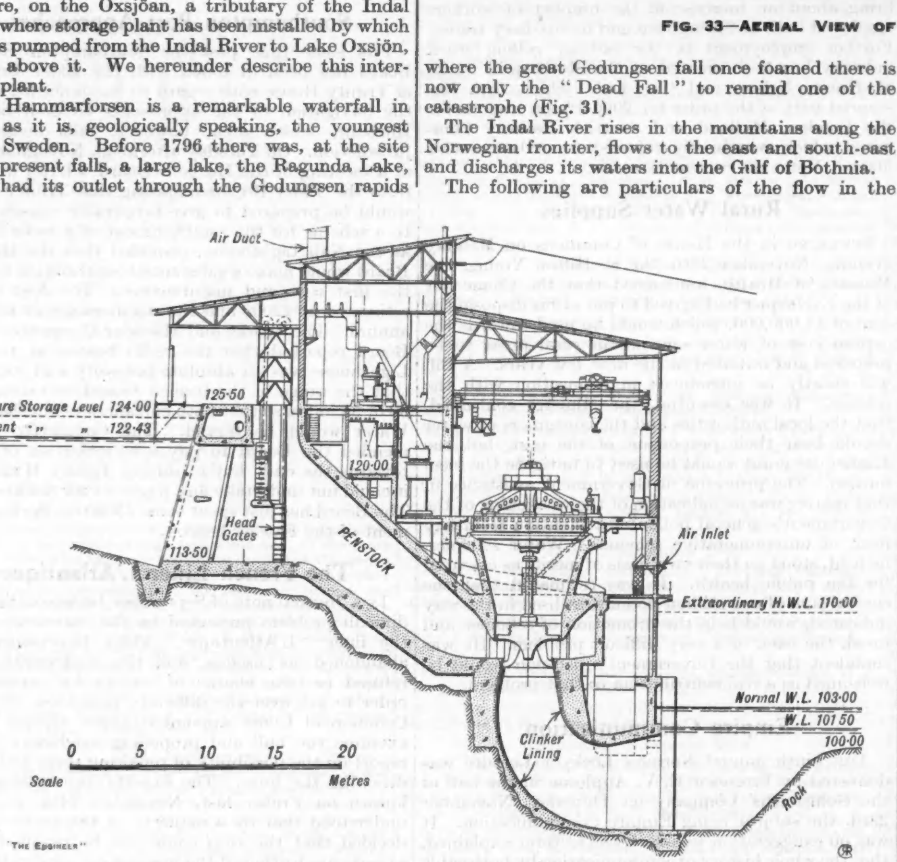

Air Duct
Future Storage Level 124·00
Present " " 122·43
125·50
120·00
Head Gates
113·50
PENSTOCK
Air Inlet
Extraordinary H.W.L. 110·00
Normal W.L. 103·00
W.L. 101·50
100·00
Clinker Lining
Rock
0
5
10
15
20
Scale
Metres
"THE ENGINEER"

FIG. 32—HAMMARFORSEN POWER PLANT—SECTION THROUGH POWER-HOUSE

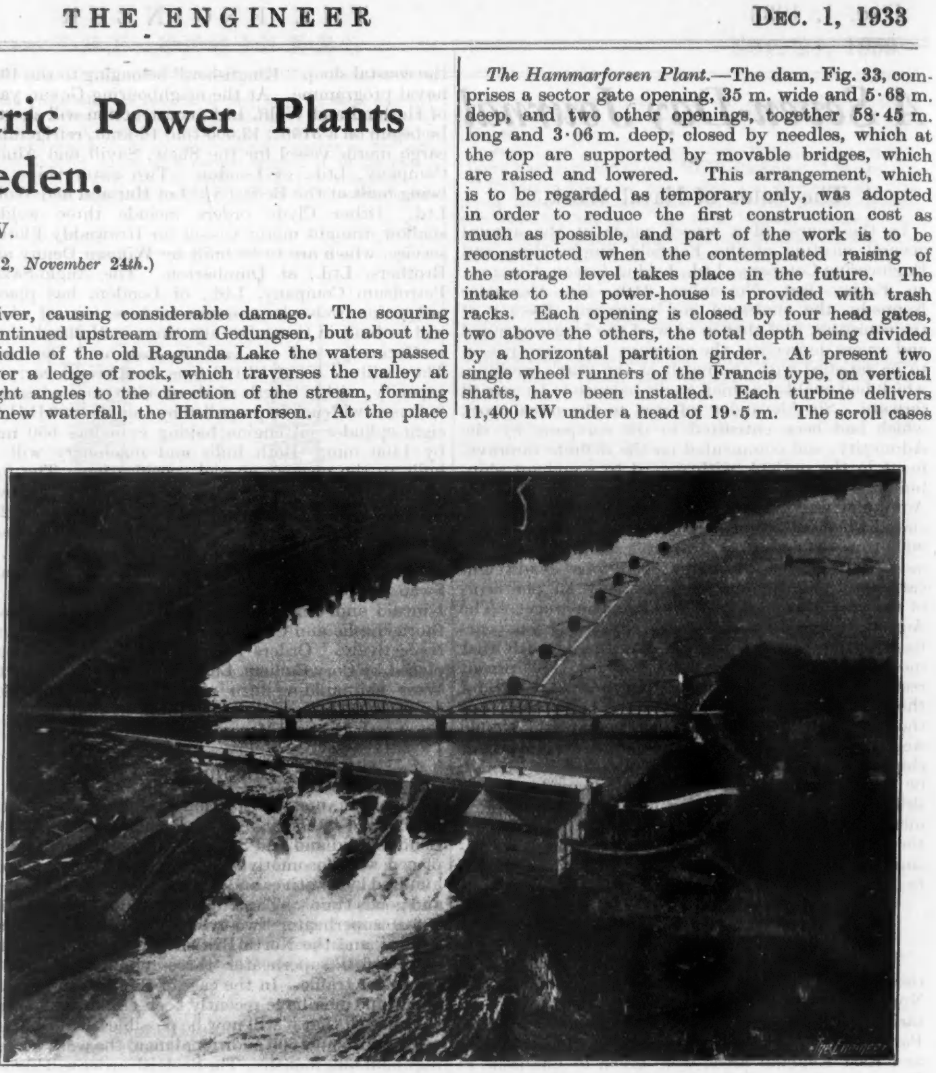


FIG. 33—AERIAL VIEW OF HAMMARFORSEN STATION

The Indal River rises in the mountains along the Norwegian frontier, flows to the east and south-east and discharges its waters into the Gulf of Bothnia.

The following are particulars of the flow in the river at Hammarforsen, which is some 18 kiloms. below Krangede:—

Catchment area..	24,000 sq. kiloms.
Flood water flow	Up to 2,500 cu. m. per sec.
Mean flow	400 " "
Flow during 50 per cent. of the year	260 " "
Flow during 75 per cent. of the year	142 " "
Ordinary minimum flow	91 " "
Head at the Hammarforsen power station	19·5 m.

The possibilities for regulating the flow are good. The low water flow can be increased to about 250 cubic metres per second by means of storage in the large natural lakes in the upper reaches of the Indal River.

The Hammarforsen Plant.—The dam, Fig. 33, comprises a sector gate opening, 35 m. wide and 5·68 m. deep, and two other openings, together 58·45 m. long and 3·06 m. deep, closed by needles, which at the top are supported by movable bridges, which are raised and lowered. This arrangement, which is to be regarded as temporary only, was adopted in order to reduce the first construction cost as much as possible, and part of the work is to be reconstructed when the contemplated raising of the storage level takes place in the future. The intake to the power-house is provided with trash racks. Each opening is closed by four head gates, two above the others, the total depth being divided by a horizontal partition girder. At present two single wheel runners of the Francis type, on vertical shafts, have been installed. Each turbine delivers 11,400 kW under a head of 19·5 m. The scroll cases are made of reinforced concrete, which is remarkable under this head. The generators are rated at 12,000 kVA, 6000–6600 volts, 50 cycles, and 93·8 r.p.m. The ultimate capacity of the plant will be about 50,000 kW. In view of this, the forebay is at present bounded by a temporary wooden dam. The space between the generator hall and the intake contains the transformers and switchgear. The total annual output of the plant in recent years has amounted to 95 million kWh. Two views of the Hammarforsen power station and falls are reproduced in Fig. 33 above and Fig. 42 on page 548.

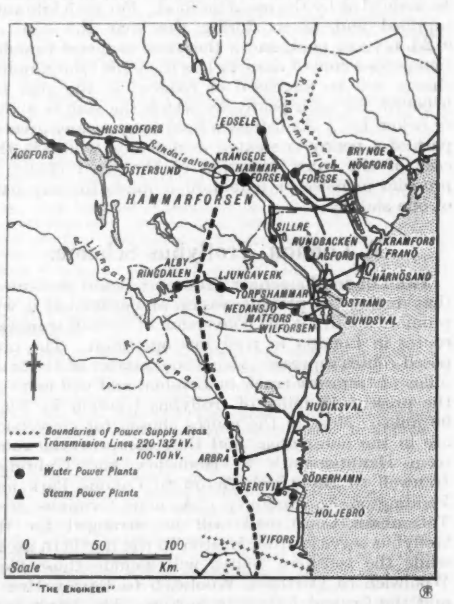

HISSMOFORS
ÅGGFORS
ÖSTERSUND
R. Indalsälven
KRÅNGEDE
HAMMARFORSEN
EDSELE
R. Ångermanälven
FORSSE
BRYNGE
HÖGFORS
HAMMARFORSEN
SILLRE
RUNDBACKEN
LAGFORS
KRAMFORS
FRANÖ
HÄRNÖSAND
R. Ljungan
ALBY
RINGDALEN
LJUNGAVERK
TORPSHAMMAR
NEDANSJÖ
MATFORS
WILFORSEN
ÖSTRAND
SUNDSVAL
R. Ljusnan
HUDIKSVAL
ARBRÅ
SÖDERHAMN
BERGVIK
HÖLJEBRO
VIFORS
Boundaries of Power Supply Areas
Transmission Lines 220-132 kV.
" " 100-10 kV.
Water Power Plants
Steam Power Plants
0
50
100
Scale
Km.
"THE ENGINEER"

FIG. 34—MAP OF HAMMARFORSEN POWER SUPPLY AREA

COFFERDAMS.

The cofferdams used for the construction of the Hammarforsen dam and power station are of great interest and are typical of the practice now generally adopted in Sweden in the construction of such works in turbulent water. The cofferdams are indicated in plan in Fig. 35 and were all constructed on the solid rock. Most of the work was carried out in the rapids, whose velocity was as high as 15ft. to 20ft. per second. The choice of methods of construction was limited by the circumstances of the situation. Watertight earth material was not available within a reasonable distance from the site; it was therefore out of the question to employ cofferdams with earth filling or in which earth was required for the purpose of obtaining water-tightness. The use of timber cribs, filled with stone, was considered as affording a comparatively simple means of building cofferdams in a rapid flowing stream. The adoption of this type of dam would reduce the risk of accidents and damage to a minimum, but it had the drawback that a relatively long period would be required for demolition on completion of the permanent works. Cofferdams of the trestle type, common in Sweden, are most suitable for rivers whose velocity is not high and they possess the great advantage of being quickly and easily removed. Their construction in turbulent rapids is, however, a matter of difficulty, and there is more trouble in making them water-tight than is encountered with timber cribs. The steeply sloping bed of the river at the Hammarforsen Falls rendered it possible to design all the cofferdams in such a way that leakage water could be run off on the downstream side of the work, thus avoiding to a great extent the necessity of pumping.

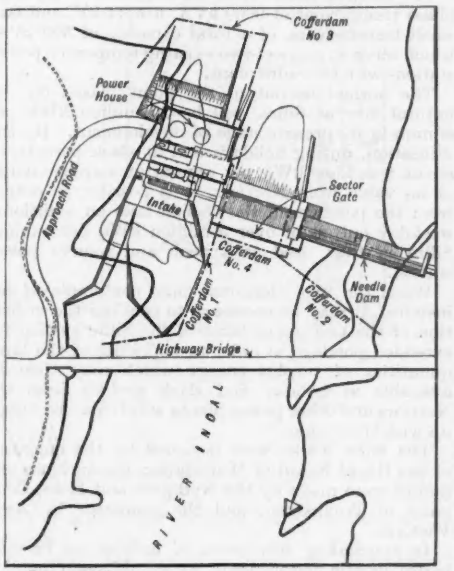


FIG. 35—PLAN SHOWING POSITION OF COFFERDAMS

The cofferdam (No. 1) surrounding the intake and power station was designed to withstand water pressure during high floods, and as delay in removing the temporary works around this part of the permanent structure was a matter of minor importance, timber crib construction was employed in building it. On the other hand, cofferdam No. 3, for the tailrace, was built in comparatively calm water, and as it was of importance to remove it as soon as possible after the completion of the permanent works, the trestle type of construction was employed. The cofferdams for the construction of the permanent dam had to be built in that part of the river where the velocity was very great; but, as they would be used only during the low-water periods which, in the Indal River, occur in winter, and as they had to be removed before the coming of the spring floods, it was decided to build them of the trestle type.

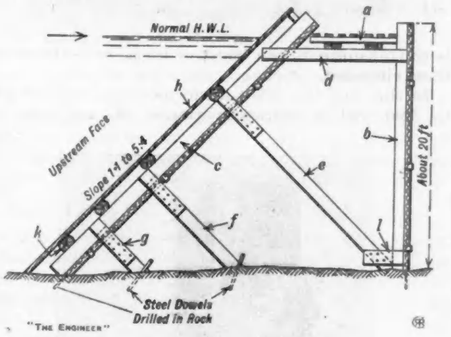


FIG. 36—CROSS-SECTION OF TRESTLE TYPE COFFERDAM

In the case of the timber crib dam No. 1, substantial water-tightness was obtained by the use of a single sheeting of vertically placed 2in. planks on the upstream side, the planks at their lower ends being shaped according to the contour of the rock surface. Jute material was nailed on to these planks to reduce leakage to a minimum, and only where the rock was very uneven was it necessary to have recourse to a second layer of short planks near the rock surface. The height of the crib dam on the average was a little more than 17ft. and the greatest water pressure occurred during the spring flood of 1926 and was equivalent to a head of 17ft. The height of this flood was practically the same as that of the greatest flood in the Indal River recorded for many years. A view of the crib dam, showing the enclosure for the construction of the power station in the background, taken during this flood, is reproduced on page 548. The river discharge at this time was about 2200 cubic metres per second. A view of the cofferdam is also reproduced in Fig. 44.

Timber trestle dams can be built without any great difficulty up to a depth of 13ft. to 15ft. by men experienced in this class of work. When, however, the depth exceeds this limit the increased velocity of flow through the partially completed structure caused by the damming of the river results in such vibration that uprights (or "soldiers"), which are round timbers of about 12in. diameter, are snapped off before the struts can be put into position. This occurred at Hammarforsen. As timber of a larger diameter was not available at a reasonable price and a change of design substituting rolled steel joists for timber would have caused delay in building the cofferdam, as well as considerable modification of the arrangements already made for building it, the difficulty was overcome by building two protection dams, or screens, which are seen in the photograph reproduced in Fig. 45. These were built out into the river alternately with the main cofferdam, one screen on each side of the latter. They were of the trestle type, but no attempt was made to make them water-tight. By this arrangement the water pressure was distributed and the velocity reduced, so that the vibration of the "soldiers," when placed in position, and before they were supported by braces, was greatly reduced. The screens also facilitated the work of completing and making water-tight the cofferdams proper. After these were finished the screens were removed.

A cross section of one of the trestle dams is shown in Fig. 36. The cofferdam was built from the stage or gangway *a*, which was successively cantilevered from the part of the trestle already completed. The steel dowel rod for the downstream "soldier" *b* and that for the front "soldier" *c* were first bored for and fixed in the rock, after which the two "soldiers" were placed in position and connected by the strut *d*. Following this the strut *e* was placed, the lower end of which was slid along the downstream "soldier" *b* by means of the plates *l* forming a fork. It was not until the downstream water level had been lowered by placing the planks *h* in position and thereby reducing the velocity of the water that the struts *f* and *g* could be erected. The horizontal runners *k* were spiked above water level in sections or panels to two of the vertical planks, and in this way the whole section could be lowered in one piece by sliding it down the face of the front "soldiers." The struts were fastened to the rock and prevented from slipping by steel drill bars inserted in holes bored in the rock. When the velocity and depth of the water was not too great this boring was done from above water level by ordinary compressed air tools with steel rods of 1¼in. to 1½in. diameter, but when the depth and velocity made this method difficult the boring was carried on inside steel tubes.

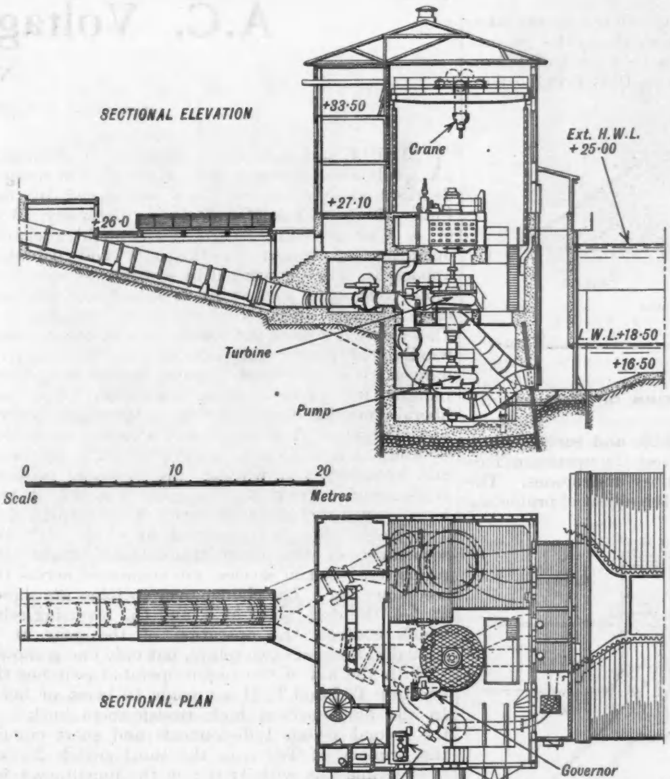


FIG. 37—SILLRE POWER STATION—CROSS-SECTION AND PLAN

Very little diving work was required in the construction of the trestle dams at Hammarforsen. Divers were employed only for a small amount of filling and tightening between the plank sheeting and the rock and at the corners of the cofferdams.

Fig. 43 is a view of the completion of the last cofferdam for the permanent dam, and Fig. 46 shows the removal of the trestles after the completion of the permanent work, an operation which was performed rapidly by means of derrick cranes. The greatest height of the trestle cofferdam, measured from the rock to the crest of the planking, was about 20ft., and the maximum head of water to which the dam was exposed was 18ft.

The consulting engineers for the Hammarforsen works have been Vattenbyggnadsbyran (V.B.B.), of Stockholm, under the supervision of whose engineer-in-chief, Mr. Erik W. Jonson, the construction of the cofferdams was carried out.

The Hammarforsen Supply Area.—The network of the Hammarforsen Company comprises:—One 70,000-volt line, Hammarforsen–Granlo; one 40,000-volt line, Granlo–Harnösand; and one 70,000-volt line, Granlo–Kinstaby, a place north of Bergvik, where connection to the system of the Bergvik and Ala Nya Company is established. The Hammarforsen system is also connected to that of the Arbra Power Company, and indirectly, through the network of the Kramfors Company, to the system of the Norrfors hydro-electric state plant. By this means a most useful exchange of energy is rendered possible within a vast area covering about 500 kiloms. from Robertsfors in the north to Vifors in the south. The Hammarforsen transmission system supplies power to the towns of Harnösand, Sundsvall, and Söderhamn, but the principal consumers are the numerous pulp industries and saw mills in the industrial districts between the Angerman River and the Hamrange River.

In Fig. 34 we reproduce a map* of the Hammarforsen power supply area which shows very clearly the extent of this important co-operative system. It should be noted that the scale indication of the Krangede plant in this plan is that of the first section of two units now under construction.

THE SILLRE POWER PLANT.

The State hydro-electric power plant at Sillre was put into operation in April, 1933. It supplies electric energy over a 70,000-volt line, at present operated at 40,000 volts, to the consumers of the Norrfors power group, and is complementary to the Norrfors hydro-electric station. During 1932 the energy generated at Norrfors amounted to 145 million kWh, the bulk of which was supplied to the numerous saw mills, sulphate and sulphite factories, and pulp mills in the coastal region between Sundsvall and Umea on the Gulf of Bothnia. In order to utilise the surplus energy of the Norrfors plant during holidays and at other slack periods, the Sillre plant has been equipped with a pump for raising water from the Indalsälven through the penstock and the head-race tunnel up to a storage reservoir—the Oxsjön lake—which has its natural discharge through the Oxsjöan, or Sillre, a small tributary to the Indalsälven—plan, Fig. 39.

The plant, although of comparatively small dimensions, is of particular interest as it operates on a head of water greater than any hitherto employed in Sweden, and is the first pump-storage installation in that country.

On a plateau north of the Indalsälven, about 60 kiloms. from the outlet of the river to the Gulf of Bothnia, there is situated a lake system including three lakes of moderate size—Oxsjön (3·5 square kilometres), Storvallsjön (3·3 square kilometres), and Storskälsjön (9·7 square kilometres). The head between Oxsjön and the Indalsälven is about 190m., and the difference in level between the lakes is about 22m. in each case, Storskälsjön being 22m. above Storvallsjön and 44m. above Oxsjön. The lakes have steep banks so that regulation is comparatively simple, and the cost of raising the water levels is small.

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* From "Hydro-Electric Development in Sweden," E. Upmark, Swedish Water Power Association, 1933.

The following are the hydrographic data of the Oxsjön stream at the outlet from the lake :—

Catchment area	220 sq. kiloms.
Lakes included in catchment area ..	20 ,,
Minimum natural flow	0·5 cu. m. per sec.
Mean flow	1·7 ,, ,,
Maximum flow	15·0 ,, ,,
Gross head after regulation..	185·5 m. to 197·5 m.

The three regulated lakes—Oxsjön, Storvallsjön, and Storskälsjön—have storage capacities of 20, 4·6, and 14·5 million cubic metres respectively, or about 40 million cubic metres, which is more than the total flow of a dry year.

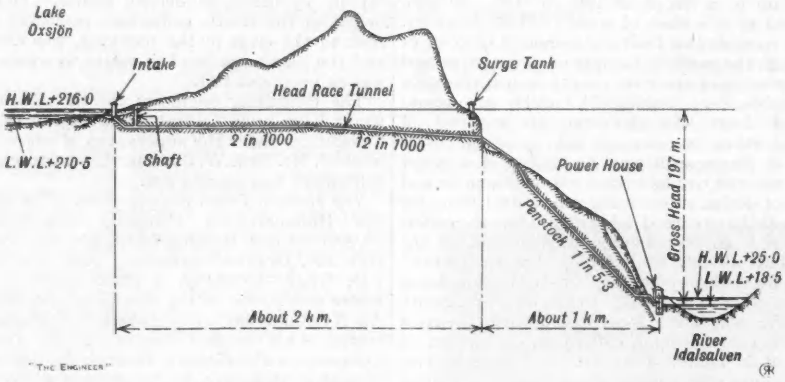


FIG. 38—DIAGRAMMATIC SECTION OF SILLRE HYDRO-ELECTRIC POWER PLANT

Dam.—By means of a rock-fill dam, 280 m. long and 8 m. high (Fig. 40) the level of the lowest lake, the Oxsjön, has been raised 4 m. above the original level. The lake can be drawn to a level of 1·5 m. below the latter, the total draw thus being 5·5 m.

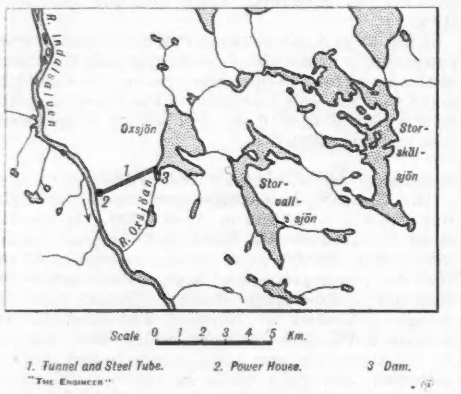


FIG. 39—SILLRE—SITUATION PLAN

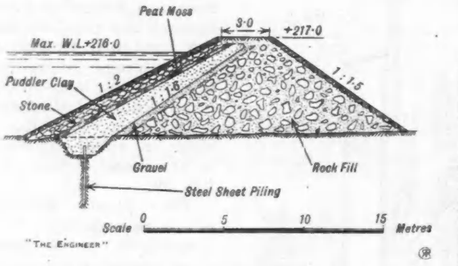


FIG. 40—CROSS-SECTION OF DAM

The dam consists of rock rubble and earth with a water-tight covering of clay on its upstream face protected by a blanket of moss and stones. The moss blanket is provided with the object of protecting the clay from extremes of temperature when the water is run down.

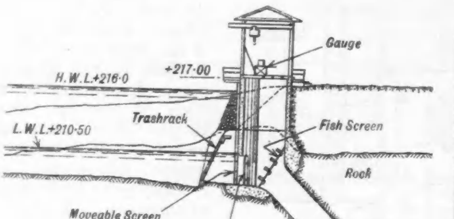


FIG. 41—INTAKE ON LAKE OXSJON—CROSS-SECTION

Intake, Tunnel, &c.—After passing through an intake, constructed on the lake side (Fig. 41) the water is carried through an almost horizontal head-race tunnel, 2 kiloms. in length, through the hill which separates the Oxsjön lake from the Indalsälven valley (Fig. 38). The tunnel has a cross section of 5 square metres, is entirely in rock, and no lining is provided. At the lower end of the tunnel is a circular, vertical surge shaft, 8 m. diameter, which permits of a range in water level of about 27 m. The steel penstock, 1·85 m. diameter, joins the head-race tunnel and is provided with a butterfly valve and an air valve. The upper part of the penstock tube is laid in an open cutting and is lined with concrete and covered with earth. The greater part of the penstock is, however, laid in an inclined tunnel blasted in the rock, and the space between the rock and the steel is filled with concrete. The plate thickness is only 6 mm., which necessitates a combined resistance of steel and rock to the water pressure. Close to the power-house the penstock is free and is carried on concrete cradles ; the plate thickness is here increased to 22 mm.

Power Station.—The power station (Fig. 37) is built on the east bank of the Indalsälven. At present one unit only, viz., No. 2, of 6300 kW, is installed. Ultimately, the plant will comprise three turbines and generators of 2500, 6300, and 8000 kW respectively, the second and third units each having a pump on the same shaft as the generator and turbine. The second unit, which is now in operation, comprises :

(*a*) A single-wheel, vertical-shaft Francis turbine (9333 H.P.) for 6300 kW at 6000 r.p.m. and 190 m. head.

(*b*) A three-phase generator, direct-coupled to the turbine, rated at 7000 kVA, 6000-7000 volts, 50 cycles.

(*c*) A centrifugal pump, of a capacity of 2·5 cubic metres per second at 190 m. head, coupled to the same shaft as the generator and the turbine and below the latter. When pumping the generator is run as a motor and fed with energy from the Norrfors hydro-electric plant.

The maximum discharge of the turbine at 100 per cent. gate opening and 190 m. head is 4·1 cubic metres per second.

The outdoor transformer station includes a three-phase transformer of 9000 kVA, 6·6/44 kV, and two small transformers, of a total capacity of 300 kVA, which serve to connect two existing temporary power stations with the Sillre plant.

The normal output of the plant, based on the natural flow at Sillre, will be 20 million kWh per annum in its present stage of development. By the utilisation, during holidays and at slack periods, of about 9 million kWh per annum of surplus energy of no value from Norrfors, it is possible to obtain from the pondage in the Oxsjön lake an additional weekday output of over 5 million kWh per annum. Sillre is thus used as a peak and reserve power station.

When the two additional units contemplated are installed, it may be necessary to consider the utilisation of the two upper lakes of the Sillre system for extended pondage in order to make use of the large quantities of surplus energy which may then be available at holiday and slack periods from the Norrfors and other power plants which may be linked up with the system.

The Sillre works were designed by the engineers of the Royal Board of Waterfalls ; the turbines and pumps were made by the Nydquist and Holm Company of Trollhättan, and the generator by Asea, Västeras.

In concluding this series of articles on Swedish hydro-electric power plants, we should again mention our indebtedness to Lieut.-Colonel A. Ekwall for permission to publish the description of the Vargon and Sillre works, and to Mr. Gottfried Berg, of Vattenbyggnadsbyran, consulting engineers, Stockholm, for similar permission in the case of the Krangede and Hammarforsen power plants. These gentlemen, their respective staffs, and Mr. B. Hellstrom, assisted us in every possible way when we recently visited these interesting works, and to them and also to the makers of the turbines and electrical machinery our thanks are due for the use of plans and photographs.

A.C. Voltage Regulators.

No. II.

(Continued from page 514, November 24th.)

A SIMPLE and inexpensive regulator for comparatively small outputs and for use on low-tension distribution systems has been introduced by the Fuller Electrical and Manufacturing Company, Ltd., of 5, Chancery-lane, W.C.2. Thoroughly reliable operation is claimed for this new and patented apparatus, which is worked by a disc-type induction motor driving a lead screw arranged to open and close spring-loaded switches, shown in Fig. 11. These switches alter the connections of the primary windings of booster transformers, and, consequently, only carry a very small current, whilst the power required for operating them is also low. They are liberally rated and contact wear is, therefore, reduced to a minimum. As the regulator is usually controlled by voltage, it takes care of the pressure at all times, and irrespective of whether the incoming pressure is constant. From the diagram, Fig. 12, it will be perceived that the secondaries of the transformers Tr I and Tr II are connected in series with the secondary of the main transformer, whilst the primaries, when in service, are connected across the secondary line. The change-over switches are shown at 1–4, the disc motor at 5, and the reversing relay which controls the operation of the gear at 6. Actually, there are two relays, but only one is shown.

With the aid of the motor-operated switches the boosters Tr I and Tr II are made to boost or buck. In the first position both transformers buck ; in the second switch 1 disconnects and short circuits the primary of Tr I ; in the third switch 2 deals in the same way with Tr II ; in the fourth, switch 3 reverses the primary of Tr I and causes it to be energised so as to make it give a boost, and finally, switch 5 alters the connections of the primary of Tr II in a like way, and also causes it to boost. By means of the switches 1–4, the primaries are thus made to buck, are short circuited, or are caused to give a boost as required to suit the load conditions according to the adjustment by the voltage-controlled relay operating in the motor circuit. With the switches in the position shown in Fig. 11, the first transformer is boosting and the second is having no effect on the pressure at all. At other switch positions both transformers can boost or buck, or both can be short circuited.

In this way the two transformers can be arranged to deal with a voltage variation of, say, plus or minus 4 per cent. in steps of 2 per cent. each, and by adding more transformers and switches any reasonable number of steps can be obtained. The

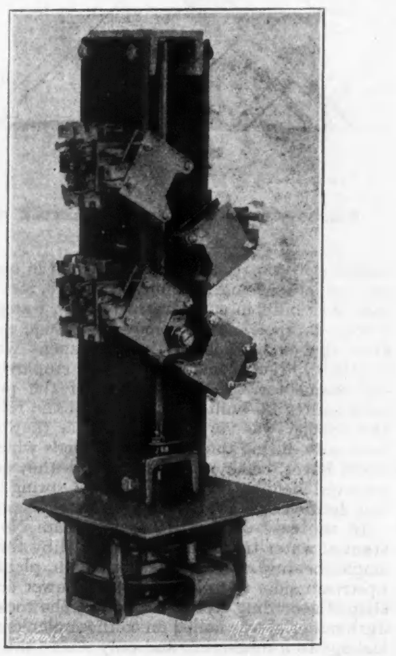


FIG. 11—SWITCHES AND OPERATING MOTOR

motor is controlled by a reversing relay actuated by a voltage-control relay—Fig. 13—which is very sensitive. It consists mainly of an electro-magnet, and a potential coil upon an induction vane of copper moves in the magnet air gap. At the opposite end of the arm there is another copper vane which serves to damp the arm movement. When the voltage varies the vane moves in the field of the electro-magnet, and this movement is utilised to operate the motor-starting and reversing relay. A special device in the voltage-control relay, which is both sensitive and robust, ensures quick breaking at the contacts.

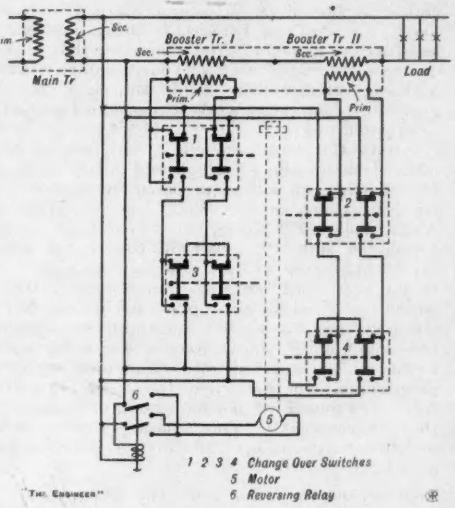


Fig. 12—Connections for Fuller Regulator

Normally, the complete equipment is contained in a single tank, divided into two compartments, one for the transformer, and the other for the switch mechanism and relays. Time delay is obtained by suitable spacing of the pivot arms operating the switches from the revolving lead screw, so that the regulator only operates on a definite drop and does not endeavour to follow any fluctuations of short or momentary duration. The regulator can be designed for indoor or outdoor service, and, if necessary, for erection on poles. It is employed on 400/440-volt or higher pressure single or three-phase feeders, and it is made in sizes up to about 250 kVA.

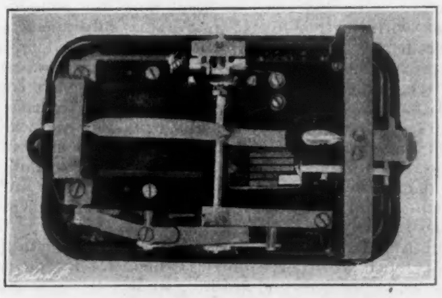
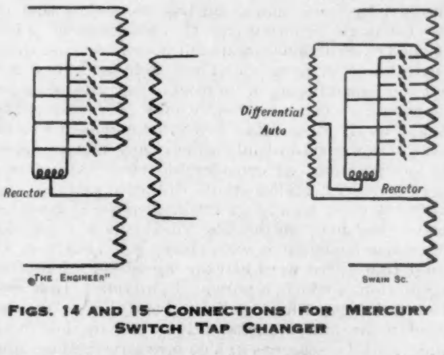


Fig. 13—Voltage Control Relay

Mercury Switch Tap-changing Regulators.

On load tap-changing gear, suitable for distribution transformers has been developed by Ferranti, Ltd. Like the switches used on the tail end booster those associated with this gear are of the mercury type and are oil-immersed. As the gear forms a unit with the transformer, no tapping leads or switch connections have to be brought outside the tank. Another advantage is that the power required to tilt these switches is very small. No doubt there are still some engineers who regard the use of switches composed of glass and mercury as poor heavy-engineering practice, but exhaustive tests are said to have proved that there is really nothing to fear. The standard rating of a mercury switch as specified by the makers is, however, no guide to its capacity for tap-changing work. When used in conjunction with this apparatus they must be capable of withstanding the most severe short-circuit currents that can arise.



Figs. 14 and 15—Connections for Mercury Switch Tap Changer

The short-circuit carrying and breaking capacities of the switch are, therefore, measured, and the safe full-load current is determined from the values obtained. To take a typical example, the normal full-load winding current of a 500 kVA, 11 kV distribution transformer is 15·2 ampères. The mercury switches used with this transformer have a tested short-circuit carrying capacity of 400 ampères, or over twenty-six times the full-load current. They also have a tested breaking capacity of at least 280 ampères at 150 volts at low lagging power factor. Although under short circuit the current may be considerably greater than normal, the voltage to be dealt with will be correspondingly below normal, so that these tests in which both current and voltage were increased are to be regarded as very severe. The mechanical gear has also been designed to ensure that it will not operate on a short-circuit current greater than four or five times full load due to a voltage drop. Life tests on individual switches, involving up to 2,000,000 breaks of full-load current at full voltage under exact operating conditions, showed that the switches were still in good condition. The switches have also proved satisfactory as regards flash-over voltage when in the open position. Five 500 kVA and seven 300 kVA, 11 kV distribution transformers have been automatically operated on a large urban system for some years, and on an average there have been 240 tap changes per transformer per day.

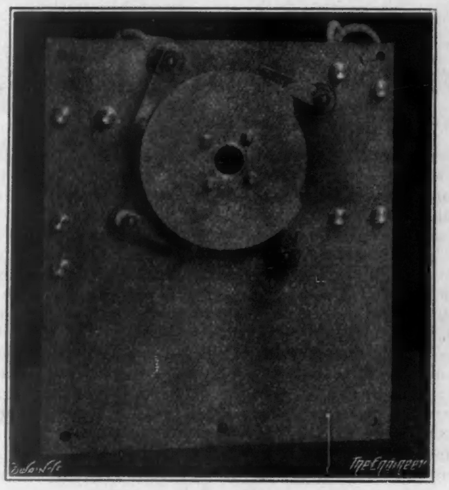


Fig. 16—Switch Operating Cam

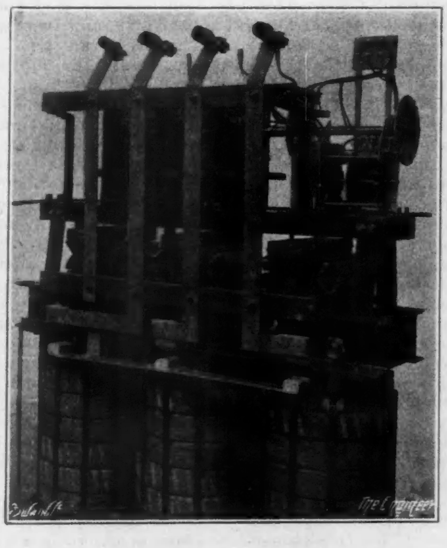


Fig. 17—Three-Phase Ferranti Mercury Switch Regulator

The electrical connections, as shown in Fig. 14, conform with recognised practice, a centre-tapped reactor being used to limit the circulating current between tappings, and a maximum of eight switches per phase is used to give fifteen running positions or fourteen steps. Current and voltage ratings of the mercury switches are the only factors that limit the range of application of the apparatus, the limitation in any particular case usually being due to one or the other, and seldom to both. With the differential auto connection shown in Fig. 15, the scope of the gear can be greatly increased by permitting one of these values to be reduced where necessary at the expense of the other. In this way the range of application can be more than doubled. In all cases the tap-changing gear is connected to the high-tension side of the transformer, and the tappings to it are brought out from the middle of the winding, as shown in Fig. 14, an arrangement that offers the advantage that, as the high-tension winding is usually the outermost winding in a distribution transformer, tappings brought up ducts from the inside winding are avoided. Another advantage which arises from the practice of bringing the tappings from the high-tension or primary windings is that it reduces the losses cost.

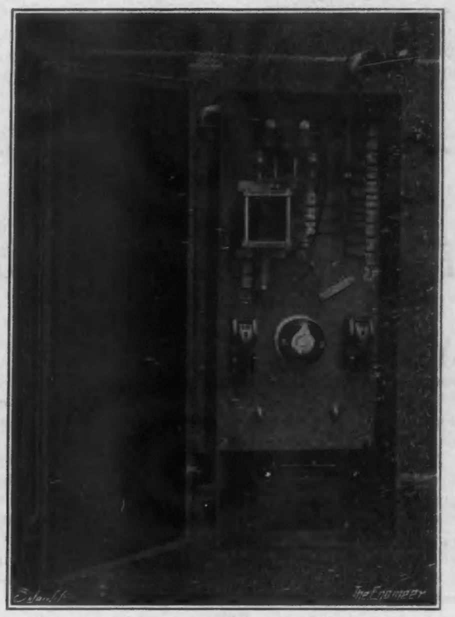


Fig. 18—Automatic Control Panel

At times of no load either the input voltage is high or a low output voltage is required, and the tap-changing gear automatically brings the full winding of the transformer into use, thus reducing the flux density, with consequent reduction in loss and magnetising current. With a voltage range of ± 10 per cent. the actual no-load losses of the transformer is said to be reduced by 30 per cent., and the no-load current by 50 per cent.

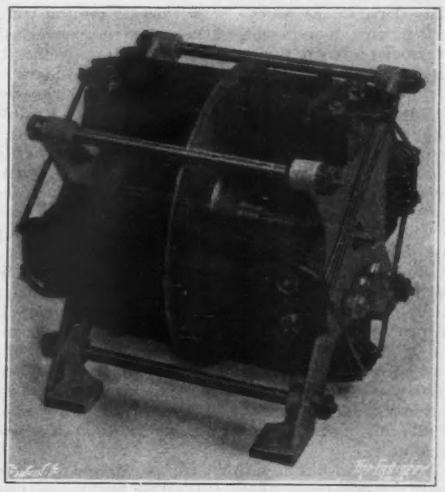


Fig. 19—Induction Disc Motor

The mercury switches are mounted on rocker arms on vertical bakelite plates around a central operating shaft. Four switches are carried by each plate, and two plates forming one phase are assembled back to back on either side of a bakelite cam mounted as shown in Fig. 16. A three-phase assembly is shown in Fig. 17, from which it will be gathered that the spacing between the phases allows easy access

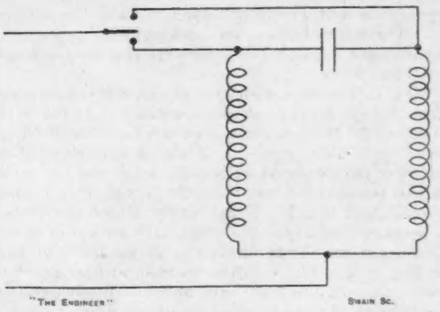


Fig. 20—Motor Connections

to the switches. The main shaft is spring-operated through single steps by an induction disc-type motor, and as all the switches of any one phase are operated by a common cam, departure from the correct sequence of operations is impossible. As shown in Fig. 17, all the apparatus is mounted on top of the transformer. It is immersed in oil, a scheme which is made practicable by the fact that no part of the mechanism requires inspection or maintenance. On-load tap-changing gear of this type can be added to standard transformers with no increase in floor space, and only approximately 20in. increase in height.

Automatic Control Panel and Motor.

As shown in Fig. 18, the automatic control panel associated with this gear is simple, which is due very largely to the fact that the power required to operate mercury switches is small. The induction disc-type motor used for operating the gear is shown in Fig. 19. Its driving elements consist of two iron-cored coils mounted on either side of a copper disc forming the rotor. As shown in Fig. 20 a condenser is connected in series with one of the coils and the flux interactions in the rotor provide the driving torque. A single two-way switch controls starting and stopping and also the direction of rotation. Owing to the low speed of the motor and its simple construction it is eminently suitable for operation under oil, and as the starting current does not exceed the running current the motor is never overloaded.

(To be continued.)

Research on Steels for High Temperatures.

At the Connaught Rooms, London, on Wednesday, November 22nd, 1933, a conference was held in connection with research on steels for use at high temperatures. Sir J. A. Ewing, K.C.B., was in the chair and there were present representatives from most of the industries concerned with this problem.

The Chairman, in opening the conference, said :—I would only remind you that we are here for the purpose of encouraging a particular industrial research, and you will expect me perhaps, as Chairman, to say a few words about its purpose and history, about the nature of the problem, and how it is being attacked, about the finance proposals, and about the reasons for helping this research. Our hosts to-day, as you know, are the British Electrical and Allied Industries Research Association, with whom are co-operating the National Federation of Iron and Steel Manufacturers. During the war the Department of Scientific and Industrial Research was created and has remained to us as one of the few beneficent legacies of the war, one of the things which we are now realising is an exceedingly valuable co-operator in the recovery of something like industrial prosperity.

The particular research which we are going to speak about to-day is a good example of the way in which that Department works. It works essentially by inviting the co-operation of the industries concerned, it associates with them and gives them specifically scientific advice, and it also supplies a considerable part at least of the necessary funds for the purpose of research. At the same time, it very properly, I think, acts upon the policy of virtually saying to industry, here is a problem which will benefit you if it is carried out and solved. It is therefore evident that you should shoulder part of the cost and we will contribute part out of Government funds, and together we will attack this problem, carrying the baby—as Mr. Wedmore once said in one of his letters to me—for a limited number of years until it is able to walk by itself. That is essentially the policy of the Department of Scientific and Industrial Research. Some of its problems are of a very broad scientific kind, and the one which we are most concerned with to-day of a general kind is the one which is in charge of a Committee over which Sir Robert Dixon presides, namely, the investigation of the high temperature properties of all sorts of metals and, I think, other bodies as well as metals.

We know also that within a comparatively few years back the constructive steels used in bridge building, architecture, &c., have been immensely improved, the range of strength and elasticity has been very much widened by various firms of steel makers by adding small quantities of other constituents. Our problem to-day, however, is a different one. We are concerned with the quality of steel to resist high temperatures generally in combination with fairly high stresses. I am afraid that is really a more difficult problem than perhaps any of the others with which steel makers have hitherto been faced, but it is a problem well worth attacking because the solution would be a very big advance indeed in our engineering possibilities, especially as regards the conversion of heat into work.

May I, therefore, shortly state how it comes about that this question of steel enters into that particular problem ? Most of you here are familiar with the fact that in the conversion of heat into work what the engineer is concerned with essentially is what is now called the heat drop, *i.e.*, the drop from a high temperature to a low temperature, which the turbine or whatever other machine he is using is going to take advantage of. At the bottom end we are now down to bed-rock. The condensers that are supplied for steam engines now have such an exceedingly excellent vacuum that there is really nothing more to get at that end, but there is no such limitation at the other end. If only we could take heat from the coal, or whatever is the fuel, into the working substance which expands in the engine, at a high temperature, then we could get much more out of it than if we took it in at a comparatively low temperature. Sir Charles Parsons demonstrated by his experiment on the steamship "King George V." the practicability of running ships' turbines with a temperature such as had never been applied, certainly in ships before, and it is a point about which every central station engineer is now concerned, namely, to get the great turbines which he uses for generating electricity to take in highly superheated steam at a high pressure, and the central station engineer finds himself limited at present by the difficulty of getting steel that will do the job. This is the clearest case of the limitation of materials checking progress in engineering. The object of this research is to see whether we cannot stretch that higher limit of temperature so that it will be a little higher than it is now. I do not think we can expect to stretch it very much and probably at the best we can only get it up by 100 deg. or 200 deg.; but it is eminently worth doing even that. I understand that Mr. Guy, who has had great experience in the design of turbines, will tell us that even 100 deg. may mean more than 5 per cent. improvement in the reduction of the coal bill for a given power.

We have this fact, then, that turbine builders are restricted, and, indeed, the users of superheated steam for any purpose are restricted, by the difficulty of finding steel capable of standing high pressure and high temperature together, and Admiral Dixon's Committee, which deals with the whole question of high temperatures in metals, has handed over a portion of their work to a Joint Committee which was created under the auspices of the Department of Scientific and Industrial Research to deal separately with this problem. This Committee of Admiral Dixon's may be called the parent Committee, whilst the Joint Committee has been fostered by the two bodies I have already named as our hosts to-day. The position is that they have gone a considerable way towards a solution of the problem. They have been carrying out systematic researches at the National Physical Laboratory and the technique of these researches is very difficult. Moreover, the apparatus for it which has been established at the National Physical Laboratory is costly, and there is a very great advantage—an obvious advantage—in co-operation for this purpose, because the job is too big a one really for any small maker to take on by himself. There has been a definite arrangement come to with the Department of Scientific and Industrial Research. The matter has been going on for several years, and in the early stages there was a contribution of £ for £ by the Department of Scientific and Industrial Research, the Department finding half and the other half of the money being found by the two bodies, which I have already named. They would like now, however, to widen the basis ; they want to make this research more active than it has been, they want to bring into it other users and other manufacturers who are concerned. Not only that, but the Department of Scientific and Industrial Research, which is very conscious of the importance of the problem, has volunteered to give a larger sum provided it is met by a larger contribution on the industrial side. Here is an extract from a letter from Sir Frank Smith, the Secretary to the Department of Scientific and Industrial Research, to Mr. Wedmore, the Director and Secretary of the Research Association. It says :

> "The Department attaches much importance to the organisation and support, by industry, of your Committee's investigations—which are intended to assist both steel makers and makers of plant to keep pace with the modern tendency continually to raise the working pressures and temperatures in steam plant for power production, and, therefore to maintain and, it is hoped, to increase the share which British industry already has in supplying the world's demand for this kind of plant and machinery. As you know, the Department is carrying out at the National Physical Laboratory, at the sole cost of public funds, a programme of research into the root problems of the behaviour of materials at high temperatures.
>
> "The work which your Committee has been undertaking is regarded by the Department as a necessary complement to its own work. It is work which is likely to lead to results of direct practical value to industry. Not only should the planning of the work be informed by industrial experience such as your Committee can provide, but we should look forward to the day when this work should be regarded as deserving a high priority in the field of industrial research represented by the Research Association movement.
>
> "As a demonstration to industry of the practical usefulness of your Committee's work, intended to enlist the co-operation of interested firms, the Department has, as you know, been meeting approximately half the cost for a number of years. We shall be gravely disappointed if this demonstration should not achieve its object. In the present financial circumstances we are bound to concentrate efforts on those fields of research which seem most likely, for whatever reasons, to bring immediate assistance to industry. You will realise that active development in the work of your Committee will, in turn, establish more firmly the claim of our own more long-range work to continued support from public funds.
>
> "With this long preamble I can turn to the offer we have made. I am pleased to confirm that the Department will be prepared, in accordance with the terms of its official letter to you of August 30th, 1932, to continue to contribute until September 30th, 1935, half the cost of the work up to £1500 per annum. Beyond that date it is our hope that industry, and especially those sections of it which are represented by the Electrical Research Association and the Iron and Steel Research Council, will be convinced that the work ought to be absorbed into their own research programme. In that event I feel sure that the Advisory Council will not hesitate to press on with the Department's more basic investigations designed to throw up problems for more *ad hoc* attack."

That means, in effect, that the Department is offering £1500 a year, provided always that industry supplies at least another £1500 a year, and I do not think that such a sum as £3000 a year or more, if it can be obtained, is at all excessive as an investment. Perhaps investment is not quite the word, because after all, what you are working for is a sort of sporting chance of a very marked betterment in the principles for the conversion of fuel into power. I should not like to put it much higher than that because we cannot be quite confident that even these protracted investigations and the long and laborious job that they involve will ultimately result in very much heightening the temperature at which steel can be used. They have already, however, as Mr. Guy assures me, resulted in a definite improved heightening of that temperature, and there is good hope for believing that with further tests on various substances as ingredients of the steel, there will be a definite improvement. At all events, it is eminently worth trying, and even if it fails you will at least have this satisfaction, that you have investigated the matter and have given industry a definite guidance and lead, and have removed—and this, I think, is a point worth mentioning—what is at present the real limits of danger in the design of some of this plant, and, further, you will have the satisfaction of knowing that this is being done as a British concern. In such a matter we do not want to allow our country to lag behind other countries which are taking up the same problem and working at it. It is clearly, as a mere piece of business foresight, desirable that British engineers who have taken the leading place in the development of steam power, should go on taking that leading place until this problem is definitely solved.

I think I ought not to take up any more of your time, and I will now call upon the other speakers and will first ask Mr. Guy to make a statement.

Mr. H. L. Guy (Chief Engineer, Mechanical Department, Metropolitan-Vickers Electrical Company, Ltd.) :—I do not want you to think that the electrical industry, for whom I speak, at first took kindly to the idea of co-operative research. In fact, we are in the position of penitents, and if salvation can be obtained by confession I am free to confess that at least the larger firms felt that they possessed technical knowledge, experience, and skill which had cost them a great deal in money and research, and they felt that by encouraging a mutual enterprise such as co-operative research they would of necessity be placing at the disposal of less provident competitors part of the stock-in-trade which they had acquired by foresight and at considerable cost. Ultimately they came to realise that the competitors who mattered most to-day in business possessed unsuspected resources of a like kind which were not insignificant compared with their own. Further, we found that there were certain urgent questions, the exploration of which, if pursued by an isolated member of an industry, would be limited and slow. We also found it was an immense advantage to deal with fundamental researches in a co-operative manner and to deal ourselves with other researches which were of more immediate and special interest to ourselves.

The importance to us of this particular research which we are discussing to-day, however, arises from the general trend in steam practice, which during the last twenty years has been marked by a steady and persistent increase in the temperature of steam employed, an increase which has averaged 100 deg. Fah. in each five years. At each definite stage in this progress we have had to encounter special problems with regard to the materials employed. For instance, in the period from twenty years ago to ten years ago we saw the almost complete elimination of non-ferrous alloys and the substitution of ferrous material. During the last ten years, however, we have been introduced to an entirely new conception of the properties of materials which demand new methods of treatment which have not yet been fully discovered. I should imagine that the problem of creep, which has been introduced with the development of high temperatures, is as important a change in steam practice as is relativity to astronomy. In the range of temperatures with which we are concerned to-day in our ordinary work, and which this research has been concerned with for the past ten years, we can no longer speak of iron and steel as having definite strength apart from the temperature to which they are subject and the temperature fall they are called upon to endure under a particular stress and so perform their duly appointed functions. We have had to develop entirely new methods of attack on our structural problems based on using materials in a plastic condition instead of an elastic condition. Moreover, apart from this question of creep, the allied problems of the embrittlement of material at elevated temperatures and the effect of oxidation and corrosion on stressed materials at high temperatures, are of equal moment. In fact, the very structural stability of the material itself may be in question. Already certain exploratory work has been done in this direction and it must be exhausted in the next stage of this particular research.

It may be urged that the ultimate user being the ultimate gainer should foot the bill. It may be argued that it is only the operator of a power station who gains by the application of the knowledge obtained from such researches, but I suggest that that is not true or, at any rate, not wholly true, because if it were, how could you explain the fact that amongst the most constant supporters of research have been the constructors of the machinery for power stations ? They are not the users of the machinery and they are not the ultimate beneficiary. The principle to seek in this matter is the one the Chairman has referred to, namely, that we shall retain the leading manufacturing position in the world's markets.

With regard to this particular research on the properties of materials at elevated temperatures, I am able to say to-day that the electrical industry will continue its support at the increased rate of contribution it made last year, when other subscriptions waned, without imposing the limitation of four years, which has been suggested.

Mr. A. J. Grant (managing director, Thos. Firth and John Brown, Ltd.) :—I speak on this subject as a steel maker and on behalf of other steel makers who are engaged particularly in the manufacture of this class of alloy steel. I should like not only to refer to high-pressure steam problems which have been previously mentioned, but also to the developments that have taken place in oil cracking and the chemical industry which calls for even higher temperatures and pressures than hitherto have been used in steam practice. It is quite evident that if this country is really to get its nose in front in developments of this nature, not only for steam work, but for chemical and oil plants, it is very necessary that systematic research should be started on this subject. I think I can safely say that the makers of alloy steels have loyally supported this work up to the present, in spite of the straightened circumstances that we have all been in lately in the steel trade, and we intend to continue to do so. Therefore I should like to appeal, not only to the makers of alloy steels, but to the makers of ordinary steel, because unless material of this nature can be satisfactorily made in this country such works as the great works at Billingham and such enterprises of the Imperial Chemical Industries as the hydrogenation of coal would be impossible. I think it is almost pitiable that the comparatively small sum which the Chairman mentioned should not be readily available from the steel industry, from the electrical industry, from marine engineers and shipbuilders, with whom pressures are increasing and superheat is increasing almost every day. It is almost pitiable that there should be any real necessity for this meeting at all to secure money for this research. The foreigners, as we know, are spending a great deal of money on questions such as this, and many private firms themselves are spending large sums of money on research. The private firms, however, which have money confine their experts to problems which are related to particular work which, to themselves, is likely to result in orders, and there is no doubt that fundamental research should be carried on at an institution such as the National Physical Laboratory. Therefore, on behalf of the alloy steel makers, I feel I am quite safe in promising what Mr. Guy has promised on behalf of the electrical industry : that we shall continue to support the work of this Committee, and I hope the basis of subscription will be very much broadened to include others who are not now supporting it. I am sure it would be in their own interests to do so.

Admiral Sir Robert Dixon, K.C.B. (director, Babcock and Wilcox, Ltd.) : My remarks to-day are made chiefly to the manufacturers and designers of steam engines and boilers, whether for use on shore or afloat. I think it will not be contested that steam in this coal-raising country will continue to supply the major power that is required in our various plants. It is obvious that the insistent call for further economy must lead inevitably to the use of higher steam pressures and temperatures, as the chairman has already said, and to modifications in design which will lead to plant less exacting in its demands both as regards space and upkeep. All these things will call for more from the engineering materials, and whether it be ashore or afloat, a ton of material will in future be expected to go farther than in the past. I am not, I think, overstating the case in saying that the continuity of progress in the economy of steam plant will only be possible if materials well fitted to retain the desired strength and form to resist wear and waste when working at higher temperatures are made available for our use.

Whilst this research in the past has, in the main, been financed, so far as industry's share of the expenditure is concerned, by those interested in prime movers for land installations, it is obvious that the knowledge which will be acquired is of equal significance and importance to the manufacturers of boilers and to all those associated with propelling machinery for marine work.

It is, I think, merely indifference, inspired by the problem being for the moment viewed as a somewhat distant one, which has resulted in this and collateral researches in the past having evolved so little interest in marine circles. Personally, however, I think the problem is imminent. I am fully persuaded that steam plant will become of increasing significance in marine work in the near future, but I am convinced that if it is once again to assume the predominant position to which its merits entitle it, it will be by taking the utmost advantage of the unique properties of steam as a heat carrier, and using it in much higher ranges of pressure and temperatures.

Thus the problem is, for marine designers, of much more than academic interest, and it behoves us to render appropriate support, and assist to get results so that the British shipping industry can walk on the ground floor as and when the advanced materials become available ; and continue, as in the past, to lead the world in economical and suitable marine designs.

I should like to say that this matter concerns the shipbuilders no less than the marine engineers and shipping people, because there is an inevitable tendency for a ship herself to be built in places where advanced machinery designs are developed and made or are readily available.

The connections, for example, between the growth of the shipbuilding industries in the Scandinavian countries and the oil engine development work is, in my view, very much to the point. It would be more than a pity, if, in advances pertaining to steam which promise so much, and which this country has pioneered from the beginning, that we as a country should lose our honourable position by reason of a lack of appreciation of the significance of this problem.

In conclusion, and speaking now for the particular boiler manufacturers with which I am associated, I can promise that they will gladly continue their support for the four years which has been suggested.

A general discussion then followed, and in conclusion the Chairman called upon Dr. Rosenhain and Sir William Larke.

Dr. W. Rosenhain, in supporting the appeal for more generous financial assistance for this research, emphasised the point made by the Chairman as to its lengthy and costly nature. The less money that was available, the more lengthy the investigations, and in another sense they were more costly, because they had to be carried out over a greater number of years. The demand for immediate or early results was a very natural one, and was a matter with which he and every member of the Committee sympathised. At the same time, there was a little misconception on the part of those who thought they had to wait three years for results. The three years period had been mentioned merely as a measure of the time for which support was asked, and it did not in the least follow that there would be no results until three years had elapsed. Whatever results were obtained were published, or at any rate made available to those concerned, as soon as they were sufficiently well established to be worth attention on a practical scale. On the other hand, it must be borne in mind that in many of these cases there was a very important time factor. The whole problem of creep, for example, was one of time, and unfortunately there had yet to be found a thoroughly satisfactory method of determining by a quick test the creep behaviour of any material. Some very ingenious methods of testing had been devised, and they gave an approximate idea of that phenomenon of intercrystalline fracture to which the Chairman had referred, but although these tests were very ingenious, the results were seldom all that were desired, and therefore it was necessary to depend mainly upon tests which extended over many weeks, and in some cases many months, and this meant time as well as money.

With regard to the actual position of the research, continued Dr. Rosenhain, he could not say much without becoming highly technical. Although the research had been started in an entirely systematic manner, it was found that it involved the exploration of an almost illimitable field if proceeded with on those lines, and, therefore, they had been led away from that strictly scientific scheme into something approximating to the trial and error methods of industry, by investigating the properties of certain types of steel which had been suggested as the results of practical experience as being promising. The molybdenum steels were a case in point, and some very interesting results had been obtained. The future course of the Committee, if it were adequately supported, was to carry out systematic work, and at the same time give attention to those particular varieties of steel which experience suggested were worth investigating.

Sir William Larke said that as one who had been the channel of appeal in connection with this research, he urged on all present the necessity for exercising their influence in the interests they represented, whether institutions or companies, in order to get this research supported to the fullest possible extent, and to bring it to the notice of those who had the deciding voice in authorising contributions. It could not be said too strongly that unless we improved our general technical and technological position we should certainly go on having losses until we had no work to do, and, speaking as one who had tried to exercise some little influence in encouraging industrial research in various capacities, Sir William said that if we did not encourage industrial research we should deserve all we got.

The Chairman, in bringing the Conference to a close, repeated that the Government offered £1500 a year for a period of three years, provided no less was contributed by industry. The British Electrical and Allied Industries Research Association had offered £750 for that preiod, and there was a contribution from the National Federation of Iron and Steel Manufacturers for £350 or £400 a year for the same period. Thus, there was still something required in order that the Government contribution might be secured. It was not the desire, in the least, to limit the amount provided by industry to £1500, and it was obvious that it would be to the very great advantage of the research if other bodies would give sums which would secure a larger total income in order that the research might proceed more quickly. It was not sufficient merely that the research should be done ; it should be done, and must be done, as quickly as by competing countries, or more quickly if this country was to hold its own.

On page 554 we print a statement by the B.E.A.I.R.A. on the present position of the research.

SIXTY YEARS AGO.

IN our issue of December 5th, 1873, we reprinted a short note taken from the *Nautical Magazine*, in which a comparison was made between the number of lives lost on British railways, by street accidents in London, and as a result of shipwrecks round our coasts. The conclusion reached was that the sea, with all its dangers from hurricanes, fires, and collisions, was much safer than railways or even streets. The comparison was undoubtedly rendered quite valueless because it dealt only with the absolute numbers of lives lost, and did not take into account the great difference in the numbers of lives exposed to the risk of loss. It was in actual fact worse than valueless ; it was thoroughly ill-timed. Hardly had the paragraph been written before an event at sea occurred, to pass, as it were, stern commentary upon it. The news was received that the "Ville du Havre" had been in collision with the "Loch Earn," and that both vessels had sunk with the loss of 222 lives. The disaster was in several respects, apart from the heavy list of casualties, a notable one. The "Loch Earn" was a sailing ship of 1200 tons. The "Ville du Havre" was a C.G.T. liner of over 8000 tons displacement. By some misunderstanding concerning the rule of the road at sea, the sailing ship proceeding at a moderate speed in a light breeze, struck the liner amidships and tore an enormous rent in her hull below the water line in the neighbourhood of the engine-room. Within a quarter of an hour the liner sank. Numbers of the passengers and crew succeeded in getting away from her in the boats, but apparently they clung too closely to the doomed ship. As she sank she listed and her masts and spars crashed down on the boats, killing many of those in them. The "Loch Earn" saved 87 lives, but these survivors found that they had been rescued from a ship that had gone to the bottom by one which was on the point of doing likewise. An addition to the tragedy was, however, avoided, for just before the "Loch Earn" sank, a passenger liner passed and took off those on board. The "Ville du Havre" was built for the Compagnie Générale Transatlantique at the Thames Ironworks in 1865. Originally she was known as the "Napoleon III.," and was driven by paddle wheels. With three similar, but slightly smaller, ships, she was placed in the hands of Andrew Leslie and Co., of Hebburn, and by that firm was lengthened by 50ft., and re-equipped for screw propulsion. As reconstructed, she had a length of 413ft., and was the largest passenger steamer afloat at that time, with the exception of the "Great Eastern." The disaster occurred very soon after she had been placed in commission again. Writing immediately after the event, we expressed our great concern at the fact that a liner of this size could be so severely damaged by a sailing ship in fair weather as to sink within a short time. We expressed the tentative opinion that she must have been structurally weak, and that her water-tight subdivision must have been defective. Subsequently, Messrs. Leslie supplied us with drawings of the hull which we published. These, together with evidence which we collected from survivors and by examining the work being done on the three sister ships, convinced us that the disaster was not caused by structural weakness, but rather by the failure of the liner's crew to close the bulkhead doors immediately after the collision had occurred. The British court of inquiry at a later date also found the liner to blame. The French court, on the other hand, blamed the "Loch Earn." The conflict between the findings caused much comment.

Beardmore High-Speed Oil Engines.

ON the occasion of a recent visit to the Dalmuir Works of William Beardmore and Co., Ltd., we inspected the large and well-equipped oil engine department of the firm, which, it will be recalled, was, earlier in the year, moved from Parkhead to Dalmuir. At this works there is now centralised all the engineering work of the firm other than that which is directly connected with the Parkhead Forge. In the Dalmuir establishment, the oil engine department has been organised as a separate entity, laid out for quantity production. We saw in course of construction nearly one hundred high-speed oil engines for road and rail transport, electric generating, and industrial and marine purposes, many of them under erection or test.

A NEW HIGH-SPEED OIL ENGINE.

As we have on several previous occasions dealt fully with the Beardmore oil engine for road and rail transport, we have on this occasion chosen for description and illustration a new six-cylinder marine engine, which has been constructed for working at moderate speeds with maximum reliability. The design of this special unit embodies improvements which have been suggested by the firm's long practical experience in the operation of high-speed oil engines.

The engine which is illustrated herewith has recently been despatched to a foreign Navy, and is one of two units to be installed in a fast-running, shallow-draught vessel for lake service. It has a normal rating of 225 B.H.P. when running at 1200 r.p.m. The cylinder bore is 6½in., the stroke 9in., and the two-hour overload rating is 250 B.H.P. During the recent official tests, which included a six-hour full-load trial, and a two-hour overload trial, both engines were shown to be capable of developing 260 B.H.P. each at 1300 r.p.m., an output which would be considerably increased by the adoption of supercharging.

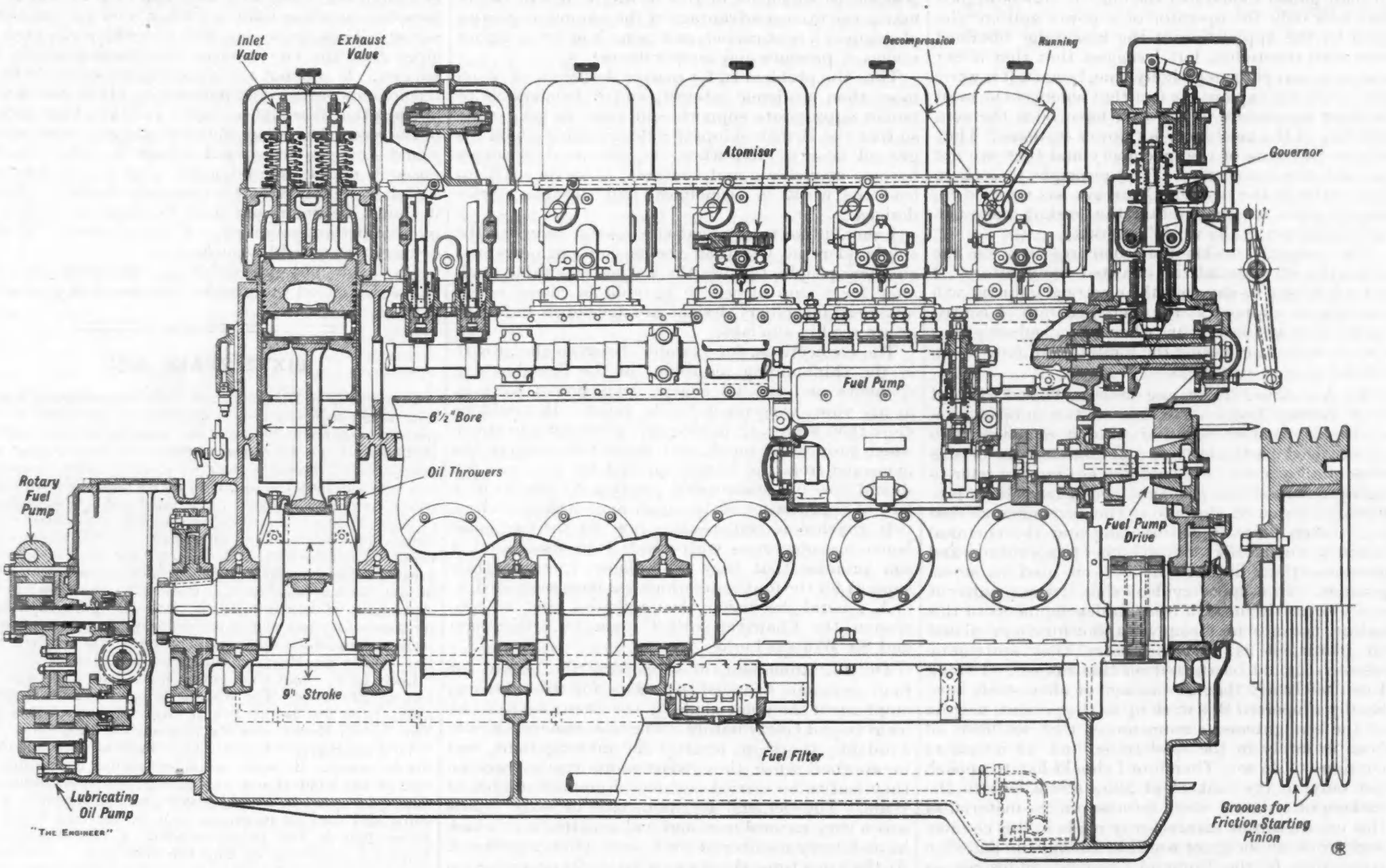


FIG. 1—LONGITUDINAL SECTION OF BEARDMORE 225 B.H.P. SIX-CYLINDER MARINE OIL ENGINE

The total weight of the engine complete with self-contained auxiliaries and clutch and reverse gear is 2 tons 7 cwt., or a little over 23 lb. per B.H.P.

We attended demonstration trials of one of the units on the test bed and were invited to test for ourselves the manœuvring qualities of the engine. We found the unit to be very quiet over all ranges of speed, and on moving the control lever there was a quick response in both the ahead and astern directions. The engine idled quietly at about 400 r.p.m., and progressive increases of speed up to 1200 and 1300 r.p.m. rapidly followed the advance of the running control lever. There was a marked absence of torsional vibration over the speed range chosen. The guaranteed fuel and lubricating oil consumptions obtained under test-bed conditions with a tolerance of 2½ per cent., were :—

	Grammes per H.P. hour.
At full load	200
At three-quarter load	195
At half-load	209
With a lubricating oil consumption of ..	5

The consumption figures at the official tests fell within the guaranteed figures without resorting to the allowed tolerance, but no attempt, it may be noted, was made to attain minimum consumption.

An interesting auxiliary fitting is a Dumbflow silencer, to the design of which we shall refer later. In this apparatus the cooling water of the engine is usefully employed to cool the exhaust and reduce its velocity, and alike, whether running light or under full-load condition, the exhaust was remarkably quiet.

FEATURES OF DESIGN.

Although we are describing a marine unit, the essential ideas of the design have been directed towards the production of a standard unit which, by suitable modification in auxiliary attachments, can be adapted equally well for generator driving or rail transport, and we noted, going through the works, several similar engines for these and other industrial services.

CRANK CASE CYLINDER AND RUNNING PARTS.

The sectional drawings reproduced herewith show clearly the main details of construction. The main framing and upper part of the crank case are a single casting of nickel chrome iron, which is of simple multi-cellular construction, the compartments carrying the cylinder liners and forming the cooling water jackets for each cylinder. The cam shaft is housed in a chamber formed at the top of the main framing, which is enclosed by a detachable cover. The lower part of the main casting carries the crank shaft bearings, there being one bearing between each pair of cylinders with additional bearings at each end. All crank shaft journal bearings are secured by underslung steel caps. The crank case is furnished with large doors giving good access and facilitating the removal of the connecting-rod bearings.

The engine underbed is a nickel iron casting, to which the crank case is bolted. It is arranged with extensions at the fly-wheel end to take the electric generator, clutch and reverse gear, or other driven units, and can be adapted to suit any particular requirements. The underbed also carries the main bearings and the layshaft for the drive to the auxiliary units which are arranged at the end of the engine remote from the fly-wheel, as shown in Fig. 1. A well is formed in the underbed to collect the lubricating oil passed through the engine system.

The crank shaft is carried in white metalled bronze bearings, adjustment being provided for by a thick shim plate. The spigoted coupling at the fly-wheel end is forged solid with the shaft, and the end of the crank shaft remote from the fly-wheel is arranged to take a vibration damper. A spur gear which drives the gear train for operating the cam shaft and engine auxiliaries, is arranged between the last main bearing and the fly-wheel bearing.

The cylinder head casting is generally made of aluminium alloy, with the valve seats of alloy steel, cast in position, but when salt sea water cooling is employed nickel cast iron is used. As our drawings show, the cylinder head contains one inlet and one exhaust valve arranged along the centre line of the engine, the fuel atomiser being at the side and placed horizontally. When the engine is designed for compressed air starting, air admission valves are provided.

The cylinder liners are interchangeable and are made from steel forgings, machined all over, the bore being ground and the outside surface treated to prevent corrosion. The top end is flanged and held between the cylinder head and the top of the crank case, copper joint rings being interposed on both sides of the flange to form the gas and water joints. The lower water joint is made by two rubber joint rings, which allow the liner to expand in a downward direction, as required.

The pistons are of the trunk type and are die cast in a special heat-treated aluminium alloy. They carry four gas rings and two scraper rings, one above and one below the gudgeon pin. The hollow gudgeon pin is free to float in the piston bosses and the small end bush. It is made from high-tensile case-hardening steel and is fitted with soft metal caps.

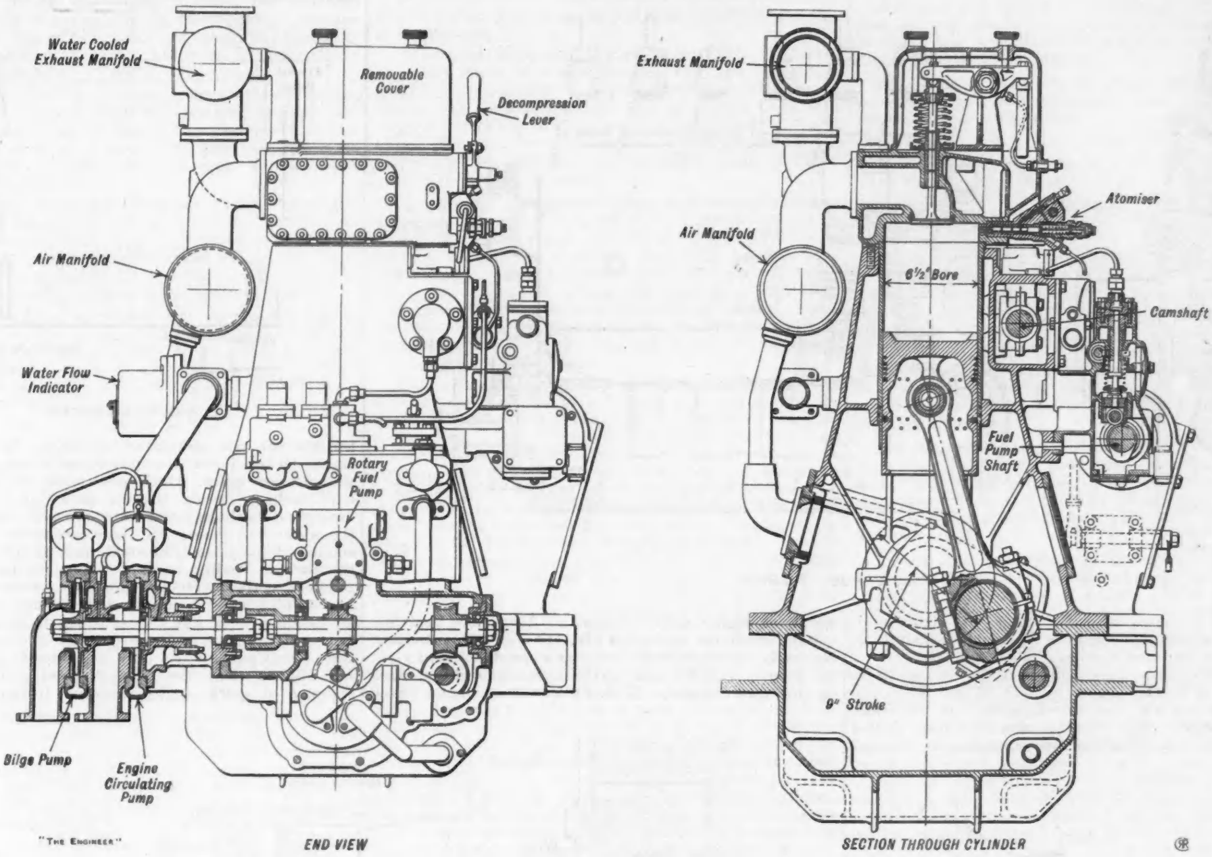
A connecting-rod of "H" section made in high-tensile steel is used and the top end bush is phosphor-bronze, while the bottom or big end bushes are made of a special bronze white metal lined, a thick adjustable shim plate being provided for adjustment. Two high-tensile steel bolts are employed to secure the connecting-rod cap to the rod. All the rods and pistons are adjusted to the same weight to secure balance of the reciprocating parts.

VALVES AND VALVE OPERATING GEAR.

The valve rocker levers are carried on a bracket which is secured to the top of the cylinder head, the whole of the valve gear being enclosed by an easily detachable cover made in light aluminium alloy. Both the inlet and exhaust valves work in renewable guides pressed into the cylinder head, and the exhaust valve is made of special heat-resisting steel. All valves are provided with two concentric springs, the upper spring cages being held in place by split cone washers fitting into recesses formed on the valve spindles. On the tops of the valve spindles there are steel caps, which contain hardened steel balls flattened locally where they make contact with the tappets on the valve rocker levers. The balls roll in their steel cages so that wear on the tappets is eliminated.

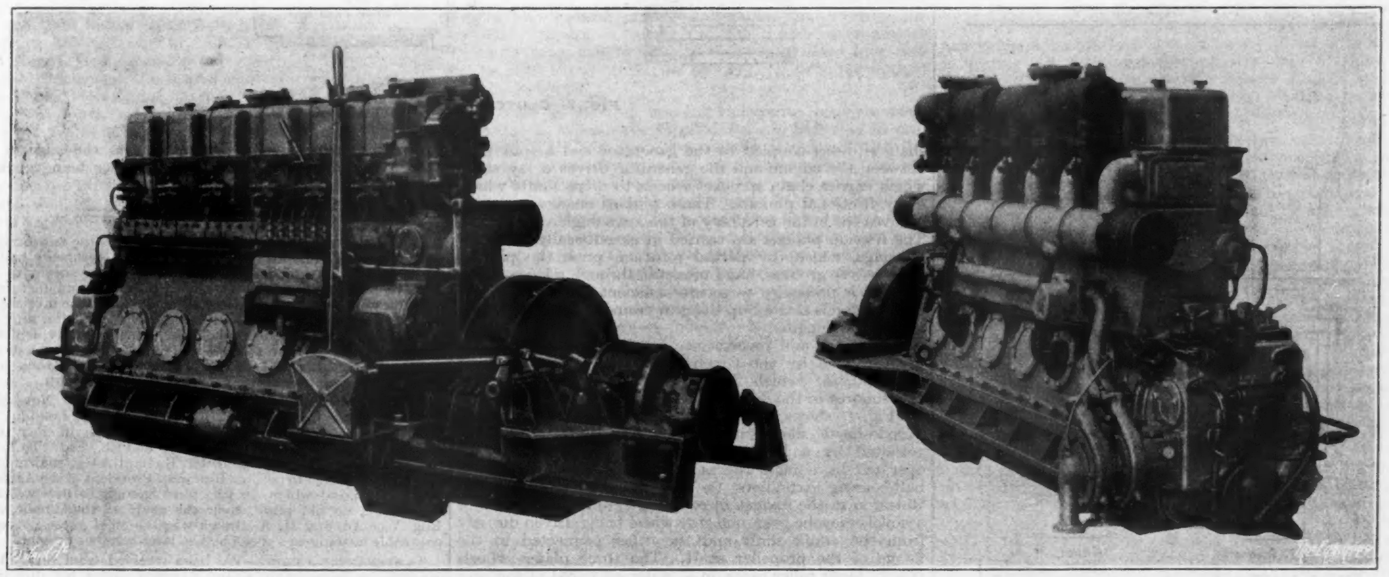
The tappets are of the roller type and are fitted with hardened steel rollers and pins, a floating bush being interposed between roller and pin. They work in cast iron guides which are spigoted and secured to the crank case with studs. The tappet guide top is positioned in the casing formed in the cylinder head and is made oil-tight by a rubber joint ring. The valve motion is taken from the tappets to the valve rockers through hollow steel push rods with hardened steel ball and cup ends which are pressure lubricated. All the valve rocker levers are finished with bronze bearings which are lubricated from the main engine system, while channels cut in the rocker levers permit oil to flow to the valve stems and push rod ends, the surplus oil being returned to the cam shaft chamber through passages provided in the tappet guides. The cam shaft can be dismantled after removing the cam shaft chamber cover, and the top caps of the bearings. In carrying out this operation the cam shaft driving gears remain undisturbed, as they are mounted on a short shaft fixed at one end by a ball bearing. The cam shaft engages this gear shaft by means of driving keys fitting into slots cut in the faces of the couplings formed on the two shafts ; the two halves of the coupling are secured together by a bolt passing through the centre of the gear shaft. The removal of the cam shaft chamber inspection cover also exposes all the tappets and rollers. The cam shaft and all the cams are drilled for lubrication, the oil being fed into the hollow centre of the shaft.

The gear train between the crank and cam shafts is housed between two walls forming a chamber in the main casing of the engine at the fly-wheel end. The gear wheels are of the single helical and straight spur types. They are mounted on fixed spindles with long bronze-bushed bearings lubricated under pressure. The first gear engaging with the driving pinion on the crank shaft is arranged at the side of the shaft so that any variation in the vertical position of the crank shaft during adjustment of the main bearings does not affect the correct meshing of the gears. The gear train, in addition to driving the fuel pump, governor, and cam shaft at the fly-wheel end of the engine, also drives a lay shaft carried in the underbed. This lay shaft transmits the drive to the cylinder jacket water circulating pumps, lubricating oil and fuel oil booster pump, which are placed at the opposite end of the engine. These are clearly shown and illustrated in Figs. 2 and 5. A power take-off is also provided for such purposes as driving a bilge pump, air compressor, &c., when required. As all the auxiliaries and other drives are taken from the fly-wheel end, they are not materially subjected to the effects of minor torsional oscillations. As shown in Fig. 1, the fuel pump is mounted on the same side of the engine as the atomisers and cam shaft. It is compact in form and is easily removable for inspection. The pump drive is taken from the gear train through an Oldham coupling, adjustment being provided at the coupling to facilitate timing the pump. The pump is of the standard Beardmore constant-stroke variable-delivery type with one pump plunger for each cylinder, the plungers being driven by a cam shaft running at half engine speed.



END VIEW SECTION THROUGH CYLINDER

FIGS. 2 AND 3—END VIEW AND SECTION OF ENGINE



FIGS. 4 AND 5—VIEWS OF ENGINE FROM FLYWHEEL AND FUEL PUMP ENDS

The measurement of fuel and the period of injection into the cylinders is controlled by partial rotation of the plunger, this movement being effected by the governor. The hardened plunger has no recesses or sharp edges on its periphery and is balanced so far as side loading is concerned. The top edge is well chamfered and communication with the controlling edges of the liner is obtained by a central axial hole and two cross holes placed diametrically opposite one another.

The pump liner is made in two parts, the lower portion having a helical upper edge which controls the amount of fuel injected, while the upper portion is recessed and fitted over the lower part, the upper end of the recess controlling the beginning of the injection period.

Screw-adjusted tappets are used to bring the plunger into correct relation with the control edges on the liner, and the plungers can be individually set to bring the cross holes of the plunger into correct radial relation with the helix on the liner.

For certain classes of service fixed timing may be employed, but when the engine has to operate over a wide range of speeds and loads it is preferable to vary the time of the injection. This variable timing of the pump is obtained by altering the angular relation of the fuel pump cam shaft to the engine crank shaft, and is done automatically by linking up the motion of the governor speed setting mechanism to the operating mechanism of the timing gear, so that the period of fuel injection is determined for each speed setting.

The atomiser is of the closed differential spring-loaded needle type. It consists of a stamped steel body with a removable hardened steel guide and hardened steel needle, an adjustable spring holding the needle upon a coned seat in the steel nozzle, which is of the multi-hole pattern. The lifting pressure of the valve can be adjusted.

A governor of simple centrifugal type, mounted vertically above the driving end of the cam shaft and worked from it by spiral bevel gears, is used. It operates the fuel pump throttle through the medium of an hydraulic relay, and is designed to control the engine speed variation within close limits. For rail traction work with electric transmission in which the engine is required to operate over a wide range of speeds the governor is fitted with a speed control mechanism designed to fix the engine revolutions at predetermined figures; thus speeds of 400, 800, 1000, and 1200 r.p.m. or any other combination may be provided for a particular duty. The mechanism, which is operated electro-hydraulically, also furnishes a simple means for coupling together two or more engine controls for operating from one driving station.

For rail traction work the solenoids which operate the valves of the governor controlling the flow of oil under pressure are in circuit with the master controller. The engine speed is, therefore, automatically varied according to the requirements of the driver. The solenoids are so arranged that in the event of failure in the electrical circuits, the engine automatically comes down to its idling speed. The oil supplied for operating under pressure the governor relay and speed control mechanism is obtained from the main engine lubricating oil system. For marine work, as in the engine we are describing, or in applications in which any speed between idling and full speed must be obtained, the solenoid valves are dispensed with, and a hand throttle lever is used, which operates the speed control mechanism through a pilot valve. Thus, for any hand throttle setting, the appropriate speed is obtained, and the load which must be carried on the engine at this speed is automatically determined by the governor. An emergency governor is also fitted in order to prevent the over-speeding of the engine in the event of the main governor failing. It is mounted on the free end of the fuel pump cam shaft, and consists of a rotating weight whose centrifugal force acts upon a spring. When the speed rises above a predetermined figure, the weight moves a trigger which is connected by suitable mechanism to the trip gear of the fuel pump. When the trigger is released the fuel supply is cut off, and the suction side of the pump at once drained.

LUBRICATING SYSTEM AND SERVICE PUMPS.

Two lubricating oil pumps are provided, their casings being cast together so as to form one unit. They are mounted on the vibration damper casing, which has also incorporated in it two Auto-Klean filters. The pumps are of the gear type, and are designated the "scavenge" and "pressure" pumps respectively. The scavenge pump suction is connected to the engine bed-plate sump, and delivers oil through the filter to the oil storage tank through the oil cooler or a radiator when provided.

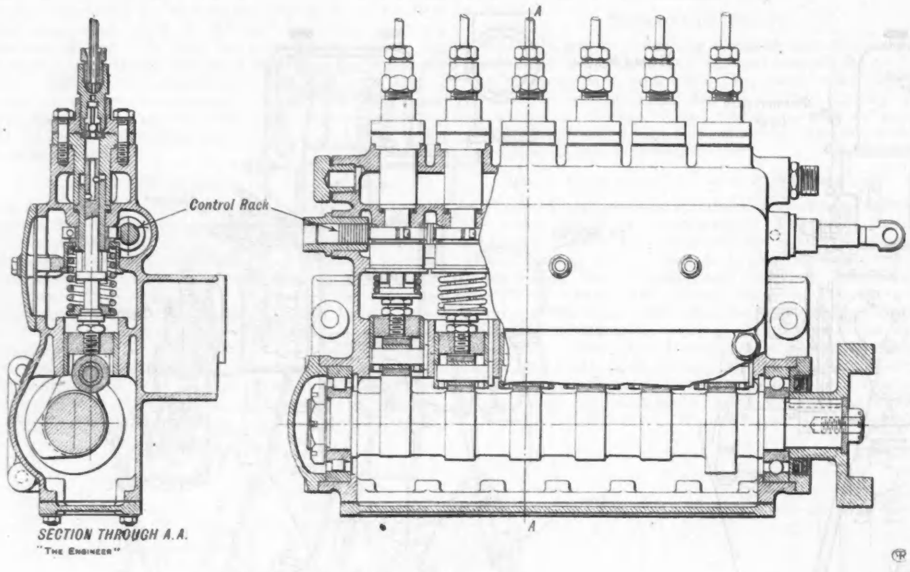


FIG. 6—FUEL PUMP

The pressure pump draws oil from the storage tank and delivers it to the engine by way of the filter, the external main rail, and the drilled passages in the crank case to the engine main bearings, and thence by drilled passages in the crank shaft to the connecting-rod big-end bearings. Suitable tappings are taken off the main system to lubricate the gear train spindles, the gears, and valve-operating mechanism, and to supply the oil relays in the governor. The booster fuel and drain pumps are of the rotary gear type built into one unit, and also mounted on the vibration damper casing. The booster fuel pump draws fuel oil from the fuel tank and delivers it under pressure to the main fuel pump. The drain pump suction is coupled to the surplus fuel collector tank and discharges the surplus fuel back to the tank. The water pump is of the centrifugal type with a cast aluminium alloy casing and a bronze impeller. The bilge pump in the case of marine applications is of the same pattern, and it is mounted alongside the circulating water pump and is driven from the same spindle. This is clearly indicated in Fig. 2.

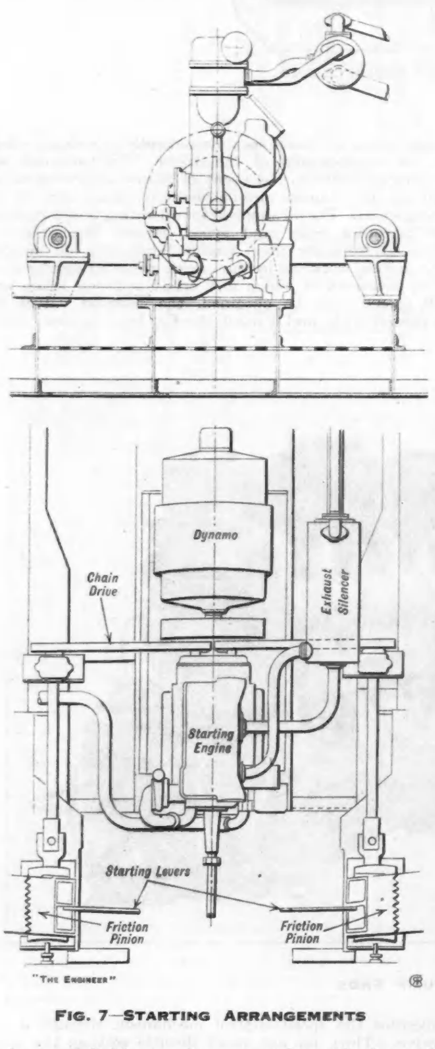


FIG. 7—STARTING ARRANGEMENTS

STARTING AND REVERSING ARRANGEMENTS.

As shown in Fig. 7, each main engine as installed in the ship is started up by means of a small Beardmore high-speed oil engine with cylinders of 3½in. bore and 5in. stroke, which also drives a 4 kW, 110-volt D.C. generator. Normally, the small engine runs at a speed of 1200 r.p.m., but when it is used to start up the main engine, it is speeded up to approximately 2200 r.p.m. The engine crank shaft is direct-coupled to the generator and a spur gear between the engine and the generator drives a lay shaft which carries chain sprocket wheels to drive shafts which carry frictional pinions. These pinions engage with vee grooves cut in the periphery of the main engine fly-wheels. The friction pinions are carried in excentrically mounted housings, which, by partial rotation, press the pinions into the vee grooves, hand pressure, through a lever, being all that is necessary to secure sufficient adhesion. After each engine is started up the gear train is disengaged from the starting engine.

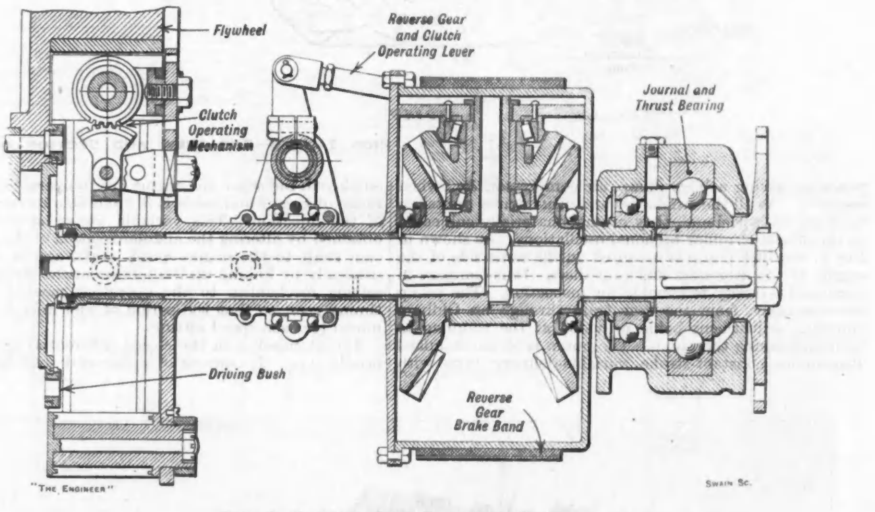

Flywheel
Reverse Gear and Clutch Operating Lever
Journal and Thrust Bearing
Clutch Operating Mechanism
Driving Bush
Reverse Gear Brake Band
"THE ENGINEER"
SWAIN SC.

FIG. 8—CLUTCH AND REVERSE GEAR

The clutch and reverse gear is of the open type, and was supplied by the Green Engine Company, Ltd., of Twickenham, which firm collaborated with Messrs. Beardmores in the design of the control lever mechanism. As Fig. 8 shows, the clutch consists of two expanding Ferodo-lined shoes, inside the fly-wheel. They are actuated by a left and right-handed screw, which is operated by a rack, the motion being transmitted by a ball-bearing trunnion to the cross-operating shaft. Rotation in the reverse direction is obtained by means of a bevel epicyclic gear, one gear wheel being driven directly from the crank shaft and the other connected to the flange of the propeller shaft. The three planet wheels run on taper roller races on a spider anchored in the gear drum, and in order to obtain reverse rotation this gear drum is held by means of an external Ferodo-lined brake band. A duplex double-thrust race is arranged on the final drive flange. Both this race and the journal race are housed in a sea-water-resisting aluminium thrust bracket, which has a seating on the engine bearers. The operating shafts of the brake band and clutch are connected by tubular levers to a control box which carries the hand control lever. These are so arranged that one lever operates both the forward and reverse direction of the craft. The interlocking device and the controls are so devised that the engine power is limited in order to suit propeller characteristics to 135 H.P. for astern navigation purposes. The reverse gear cannot be engaged until the engine revolutions have dropped to the idling speed.

SILENCING ARRANGEMENTS.

The Dumbflow patented silencers, already referred to, were supplied by the Universal Electrical Manufacturing Company, of Peckham, and there are two—one silencer per engine. They were made under a guarantee to render the exhausts inaudible at a distance of 150 m., while both the size and weight of the units and the back-pressure were required to be reduced to the minimum.

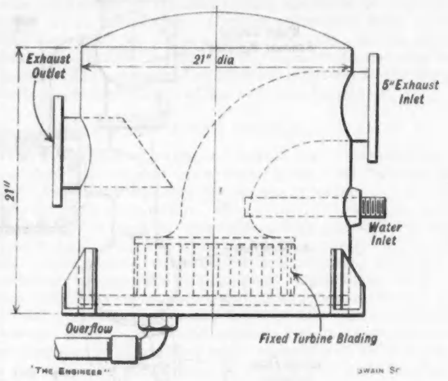


FIG. 9—SILENCER

As Fig. 9 shows, each silencer is 21in. high and of the same diameter, the 5in. exhaust from the engine being led into one side and out of the other. Water from the engine jackets is led into the silencer where it mixes with the exhaust gases, which are caused to pass through fixed turbine blading, thereby imparting a rapid rotary movement to the gas and water mixture, thus converting the water into foam. By these means an instantaneous cooling of the gases is effected, and, as the gases leaving the turbine blading enter a vortex, or point of lowest pressure in the revolving foam, back-pressure is avoided. The surplus water is continuously drained away through an overflow pipe, any excess being discharged with the gases. By means of the arrangement described, it has been found possible not only to eliminate exhaust noise, but also to clean the exhaust gases and prevent the emission of sparks under abnormal working conditions. A vacuum-breaking port is provided in the silencer in order to prevent any possibility of water being sucked back into the engine.

A RAPID BUILDING FEAT.—The contract for the new Spillers flour mill at Avonmouth stipulated that the steel work had to be in position in eight weeks. This included the survey of the site, the preparation of the working details, the manufacture of the steel and rolling of the materials at the mills, the fabrication in the shops, the delivery and unloading at the site, and the actual erection of the steel members. This was duly achieved by Dorman, Long, who took 4½ weeks from the receipt of the order to effect the first delivery at the site, and then only 3½ weeks to erect the entire 1500-ton steel framework.

W. H. ALLEN, SONS AND CO., LTD.—Last Saturday, November 25th, there was held at the Criterion Restaurant, London, the twenty-first annual dinner of the Association of Past and Present Students of W. H. Allen, Sons and Co., Ltd. To mark the "coming of age" occasion, Mr. Richard Allen, chairman of the firm, was asked to become Honorary President of the Association, a proposal which he was kind enough to accept. Mr. K. Rowell, an old pupil, took the chair at the dinner, and Eng. Vice-Admiral H. A. Brown was the chief guest. A very enjoyable evening was spent by the large number present.

TEMPERATURE CHART.—We have received from Sir Robert Hadfield a temperature chart prepared under his direction. It is a new edition, with considerable improvements and additions, of a previous chart prepared some years ago. Temperatures are given on the Centigrade scale, and the range extends from Absolute Zero to the temperature of the Electric Arc (3700 deg. Cent.). On the right-hand side of a conventional thermometer stem, the melting and boiling points of various materials are tabulated, these being separated into two columns for more ready reference. The first column shows the boiling points of the elements, and the melting points of refractories and other materials used principally in metallurgy. The second column is confined to the melting points of the elements. On the left-hand side are indicated the temperatures corresponding to the temper colours of steel, together with various natural and industrial temperatures. The purpose of the chart is to present to those concerned in convenient form various temperature data of general interest.

Railway and Road Matters.

Locomotive "No. 6201" of the L.M.S. Railway, sister to the "Princess Royal," has been named "Princess Elizabeth."

The "Royal Scot" train of the L.M.S., which has been touring the United States and Canada, and has covered there some 13,000 miles, is due back in England by way of the "Beaverdale" early in December.

As related in our Seven-Day Journal, the Southern Railway is about to extend its electrification services by a further 23 route miles, *i.e.*, from Orpington to Sevenoaks, and from Bickley and Chislehurst to Sevenoaks *viâ* Swanley Junction.

It is reported that the Campbeltown and Machrihanish Light Railway, which is nearly 6¼ miles long, is of 2ft. 3in. gauge, and runs across the Mull of Kintyre, is to be wound up. It was opened on August 17th, 1906, and has three locomotives, six carriages, and two vans. Its failure is due to road competition.

The London Passenger Transport Board seeks for powers in the Bill that will come before Parliament next year to substitute trolleybuses on 90 miles of the routes now served by tramways. All these are in the outer London area, presumably because the trams there are operated by overhead equipment and not by conduit.

Workmen engaged on alterations to Wembley L.M.S. station have brought to light a ninety-six years old cast iron plate bearing the initials of the London and Birmingham Railway, London's first main line railway. The plate, which was affixed to the bridge carrying Wembley High-road over the railway, dates from the opening of the line from Euston to Boxmoor in 1837.

The Ministry of Transport railway statistics for the month of August show that, compared with the corresponding month of 1932, the number of passenger journeys increased by 5·7 per cent., and the receipts therefrom 13·9 per cent. The tonnage of freight rose by 9·9 per cent., and the freight traffic receipts by 7·0 per cent. The freight train mileage was 3·5 per cent. higher, the average train load rose from 115½ tons to 121 tons, and the net ton-miles per engine-hour from 436½ to 457¾. The last represents the speed in transit and this is very gratifying.

Speaking before the Great Western Railway Debating Society on October 19th, Mr. A. S. Quartermaine, that company's assistant chief engineer, said that steel sleepers had been laid on 156 miles of the Great Western. The lecturer also spoke of various methods of packing the sleepers, and said that while experiments had been made with pneumatic "tampers," the method had not been found better or more economical than the traditional method of "beater" packing. Fly-packing, a process in which the track was lifted and a suitable quantity of fine ballast sprinkled over the sleeper bed, was, however, being used extensively.

According to the Railway Returns there were, on December 31st, 1932, 668,868 wagons owned by British railways, a decrease during the year of 13,891. There were also 13,605 brake vans. The total tonnage capacity of the wagons was 7,475,433 tons, a decrease of 119,080 tons. The average capacity per wagon was 11·41 tons, as compared with 11·35 tons. The number of wagons of a capacity of 20 tons and over—exclusive of special vehicles—was 28,689, as against 28,915 at the end of 1931; 26,700 of these in 1932 were allocated specially to mineral traffic, as compared with 26,867 in 1931. In view of the agitation in certain sections of the public Press for 20-ton wagons these decreases show that the wisdom of the railways is against that idea.

In our Annual Article of January 13th last, "British Railways in 1932," we gave a description of the deviation of the Cheadle single-line branch of the London, Midland and Scottish Railway. The railway runs from Cresswell, on the main line of the former North Staffordshire Company, to the terminus at Cheadle, and is 3¾ miles long, including Cheadle Tunnel, half a mile in length. Owing to coal settlement the tunnel needs considerable repairs, but it has been found to be a less expensive matter to divert the line at a point north of the intermediate station of Tean by building a new railway 2¼ miles in length, all in the open. This has now been completed, and the line was opened on Sunday, November 26th. The work has involved the construction of two bridges over public roads, and one over the river Tean, and some 145,000 cubic yards of earthwork had to be dealt with.

On the evening of Saturday, August 26th, a passenger train on the Sirhowy branch of the London, Midland and Scottish Railway was detained at Tredegar Lower Junction home signal because a Great Western train was passing on to the same line at the next box in advance. An engine and van should therefore have been detained at the next box in the rear, Nine Mile Point No. 2, but for some reason which the man could not explain, the signalman there lowered his starting signal and allowed the van to proceed. Recognising his error later, he telephoned to Tredegar Lower Junction signalman, and that man put the home signal to "clear" in order to get the passenger train out of the way. Whilst the signal was "off," the engine and van approached and the collision followed. The accident was inquired into by Colonel Trench, who puts the blame for the mishap on the signalman at Nine Mile Point No. 2.

The circular railway which runs around Paris will probably be closed to passenger traffic shortly, except on the electrified section between Auteuil and Courcelles, where it joins the main line from the Gare Saint-Lazare. Prior to 1900 this railway offered the only means of mechanical transport in Paris, apart from a few lines of compressed air and steam tramcars, and its prosperity declined rapidly with the coming of the motor omnibus. Attempts were made recently to galvanise it into life with the use of oil-electric locomotives, but the experiment failed, and the company proposes to suppress the passenger service from the beginning of next year. Omnibuses run so frequently at all points around Paris that competition for traffic is no longer possible. The railway does useful service between the goods termini of the main lines which are situated near it, and it will no doubt continue to be employed for goods traffic.

Notes and Memoranda.

An experimental tea factory is to be put up at Serdang, Federated Malay States, where a considerable plantation has been laid out.

The Krivoi Rog iron deposits of Russia are estimated to contain 700 million tons of ore, of which 211 million tons are considered to be commercially workable. The ore is said to be of the red hematite type with a content of 66 per cent. of Fe. There are also deposits, said to contain 10 billion tons of 40–45 per cent. quartzite iron ore, in the district.

On account of the hook of the hoisting tackle on a crane, especially those of a steel foundry that are exposed to great heat, developing cracks and resulting in a disastrous failure, the Demag Company has evolved a hook that might be described as being made of "ply steel." Should any of the plies develop a defect, it will not reduce the strength of the hook beyond the safety limit, and that piece can be easily replaced.

The recently opened power plant at Vernon, California, which has a capacity of 35,000 H.P., is driven entirely by oil engines. The present installation of 37,500-kVA consists of five 7500-kVA units. Each unit consists of a 7000 B.H.P., eight-cylinder, double-acting, two-cycle, 167 r.p.m. oil engine, direct connected to a 7500-kVA, 0·8 power factor, 7200-volt, 50-cycle generator. These Hamilton-M.A.N. engines, built by the Hooven, Owens, Rentschler Company, are the largest now in stationary service in the United States.

Some very striking figures regarding actual tooling costs applicable to heavy-duty milling in cast iron of medium hardness were quoted by Mr. R. E. W. Harrison during the course of a paper read recently before the American Society of Mechanical Engineers. It was stated that a milling cutter designated type A will remove 6000 cubic inches per grind and can be re-ground seventy times. A set of blades for such a cutter costs the user approximately £4 5s., so that more than 400 cubic inches of metal can be removed for 1d. invested in high-speed steel. With a cutter designated type B, which has an actual metal removal life of 1,620,000 cubic inches per set of plates costing the user £5 15s., a volume of nearly 1200 cubic inches of cast iron can be removed for an expenditure of 1d. on high-speed steel.

An article in *Chemical and Metallurgical Engineering* points out that blast-furnace slag, owing to its content of lime, alumina, and silica, is a cheap and suitable material for the manufacture of glass. Experiments have shown that molten slag straight from the blast-furnace may be directly converted into glass, thus effecting a fuel saving. The glass produced can be readily cast or rolled, but it is difficult to make it transparent, owing to the presence of 1 per cent. iron oxide, although dark-coloured glass can be readily produced. A semi-transparent glass with a high refractive index, and which is opaque at a distance of a few yards, can also be made, according to work at the Alabama Polytechnic Institute. These glasses have a low coefficient of expansion and a great strength, are heat-resisting and unattacked by boiling water, hot caustic soda and boiling hydrochloric acid.

Sound travels freely through chemically dried air, particularly at low temperatures. The introduction of small quantities of moisture promptly damps off the sound, especially tones of high pitch. Peculiarly, this phenomenon does not occur when pure nitrogen is substituted for the air, in spite of the fact that air is nearly 80 per cent. nitrogen. A shift to pure oxygen in the experiment reveals this latter gas as the guilty party. But oxygen alone is rather ineffective. Water vapour must also be present to affect the sound waves. Experimental records agree with the theory that the water molecules catalyse, or inspire oxygen molecules to pick up sound waves, convert them into heat or other motion, and thus destroy the sound. The extent to which all this occurs varies greatly with the frequency or pitch of the sound. Thus arises one more good argument for the new art of air conditioning in public buildings.

A new method of case-hardening has recently been introduced, which, says *Shipbuilding and Shipping Record*, overcomes the disadvantages usually associated with the process as ordinarily practised, viz., the necessity of having boxes of sufficient size to contain the piece, and the time taken. In this new process the parts to be hardened are dipped directly into a bath consisting of a special case-hardening mixture in the form of a thin paste, and they are then put into the furnace without any packing. In addition, the time required in the furnace is considerably less than when the ordinary box-hardening process is required, the pieces, on being taken out of the furnace, being plunged into an oil bath, where they are cooled off. Thus, with ordinary mild steels the carburising time to obtain a depth of 1 mm. is from sixty to eighty minutes after the work has attained the furnace temperature, which should be in the region of 930 deg. to 940 deg. Cent. It is also claimed that the short time required for treatment offers the further advantage that the possibilities of distortion are greatly reduced.

The recently opened bridge over the Teesta River is the largest concrete arch in India, and was built on a steel arch centering. As it was difficult to calculate the deflection of the centering under the load of the concrete, some method of getting over this difficulty had to be devised. This was done, says *Indian Engineering*, by means of sand bags—the steel arch was loaded with exactly the same weight as the weight of the concrete in the arch rib, and as the concrete was placed in the forms the sand was thrown into the river, thus keeping the load uniform and the shape of the arch constant. This, we understand, is the first time that this method has been used in India. Similarly, when removing the steel supporting arch, sand bags were again placed on the steel arch until the downward movement was sufficient to enable the packing between the concrete and steel arches to be removed; this allowed the concrete arch to take up its own position without shock. This is a most important consideration in concrete construction of this nature, as the concrete at this stage has only developed a certain proportion of its ultimate strength.

Miscellanea.

Ten new food canning factories have been established in Great Britain this year, making a total of eighty-two canneries throughout the country.

Statistics show that England has exported 15,000 motor cycles and tricars valued at £500,000 during this year. During the first ten months of this year we exported 158,000 "push" cycles.

A resolution confirming the amalgamation of the Ross Institute with the London School of Hygiene and Tropical Medicine was passed unanimously at a meeting of the members of the Ross Institute.

The coal deposits of the Faröe Islands are to be developed by Danish interests to the extent of 100,000 tons a year as a preliminary. It is estimated that there are 100 million tons of coal available.

A regulating dam is to be built at Fort Peck, on the head waters of the Missouri River. It is to be of earth, will have a height of 230ft., and will impound 17,000,000 acre-feet of water. The estimated cost is about 75,000,000 dollars.

Eighty per cent. of the contracts for the equipment of the new sugar-beet factories in the Irish Free State, amounting to more than £1,000,000, have been given to Germany, and the remaining 20 per cent. to Czecho-Slovakia.

The Board of Trade gives notice that it has referred to the Standing Committee an application for an Order in Council to require the marking with an indication of origin of chain or pulley blocks, whether imported complete or in parts.

The two new liners for the New Zealand trade of the Blue Star Line, which have been ordered from Harland and Wolff, of Belfast, are to be finished by the end of next year. They will be 515ft. long by 70ft. beam, and have a speed of about 16 knots. The propelling machinery will be oil engines.

The capacity of the ferro-manganese works at Sestafoni, in South Georgia, the erection of which started in 1930, is reported in the *Iron and Coal Trades Review* to be 150,000 tons per annum in eighteen furnaces. Up to the present three electric furnaces have been in operation. A new railway between Schoropanj and Sestafoni is used for conveying the manganiferous ores to the furnaces, while coal is furnished by the Tkwibuljski coalfield, some 24 miles from the works.

Ten motor omnibuses have lately been despatched from Birmingham to Hyderabad for use by the Nizam's Railways, which will now have the largest and most up-to-date motor fleet in India. Twenty-seven motor omnibuses were ordered from England three years ago when the need for co-ordinating the road and rail services became apparent, and it was decided that the State, in addition to running railways, should run public road vehicles.

A plan to shift the course of the Charles River for about three-fourths of a mile in Cambridge and Brighton, Mass., has been prepared by the Metropolitan District Planning Commission at Boston, Mass. With an estimated outlay of about 700,000 dollars, it is intended to swing the channel of the river eastward toward Soldiers Field and the Harvard Stadium; to build a bridge across the river at Gerry's Landing, near the Cambridge Hospital; construct two traffic circles at the ends of the bridge, and build two overpasses for foot traffic.

Manchukuo is reported to be making plans for the erection of an oil refinery at Hulutao. This plant will have a daily capacity of 4000 barrels of gasoline, and may commence operations with imported crude oil, probably from Russia. In the neighbourhood of Hailar there are crude oil seepages, and geologists are there to prospect and prepare for drilling this summer. If oil is brought in paying quantities, another refinery may be built at Hailar. There are, says the *Far Eastern Review*, said to be two most important and promising oil fields in Manchukuo. One is near Chiufutan in Jehol Province.

The change in the basis of manufacture which brought into existence the production engineer actually took place, said Mr. Still in an address to the Industrial Administration Students' Union, at Thames House on November 23rd, during the nineteenth century, when the engineering industry had become so complicated that some measure of specialisation became necessary. Interchangeability brought standardised tools and gauges; the tool-room brought the tool designer, who became a specialist; and the necessity for studying the operations and processes for which the tools were intended brought the planning department; while further development brought the progress man and the inspector. It was at this stage that the production department became necessary to preserve a proper co-relation between the stages of manufacture, and the production engineer to control both the manufacturing processes from the very beginning, and the supply of raw material.

The construction work under the national "grid" electricity scheme has been completed so far as the South Wales section is concerned, and thus forms the concluding stage of the national scheme, which links up every big station in England, Scotland, and Wales. According to Mr. A. P. Healy, the engineer-in-charge of the "grid" in South Wales for Messrs. Kennedy and Donkin, consulting engineers to the Central Electricity Board, the construction of the South Wales section has taken two and a half years, and involved the connecting up of Gloucester, Portishead, Newport, Cardiff, Upper Boat, the new station at Tir John North, Swansea, and Llanelly. Six hundred pylons have been erected and 300 miles of aluminium wire have been used. During the construction of the transmission lines many different types of obstacle had to be overcome, including the crossing of six rivers, at each of which clearance had to be provided for shipping. These crossings are from high towers, which now form landmarks the whole way from Gloucester to Swansea. The towers at Newport and Newnham are approximately 300ft. high.

CONSTRUCTION OF THE HAMMARFORSEN POWER STATION, SWEDEN

(For description see page 538.)

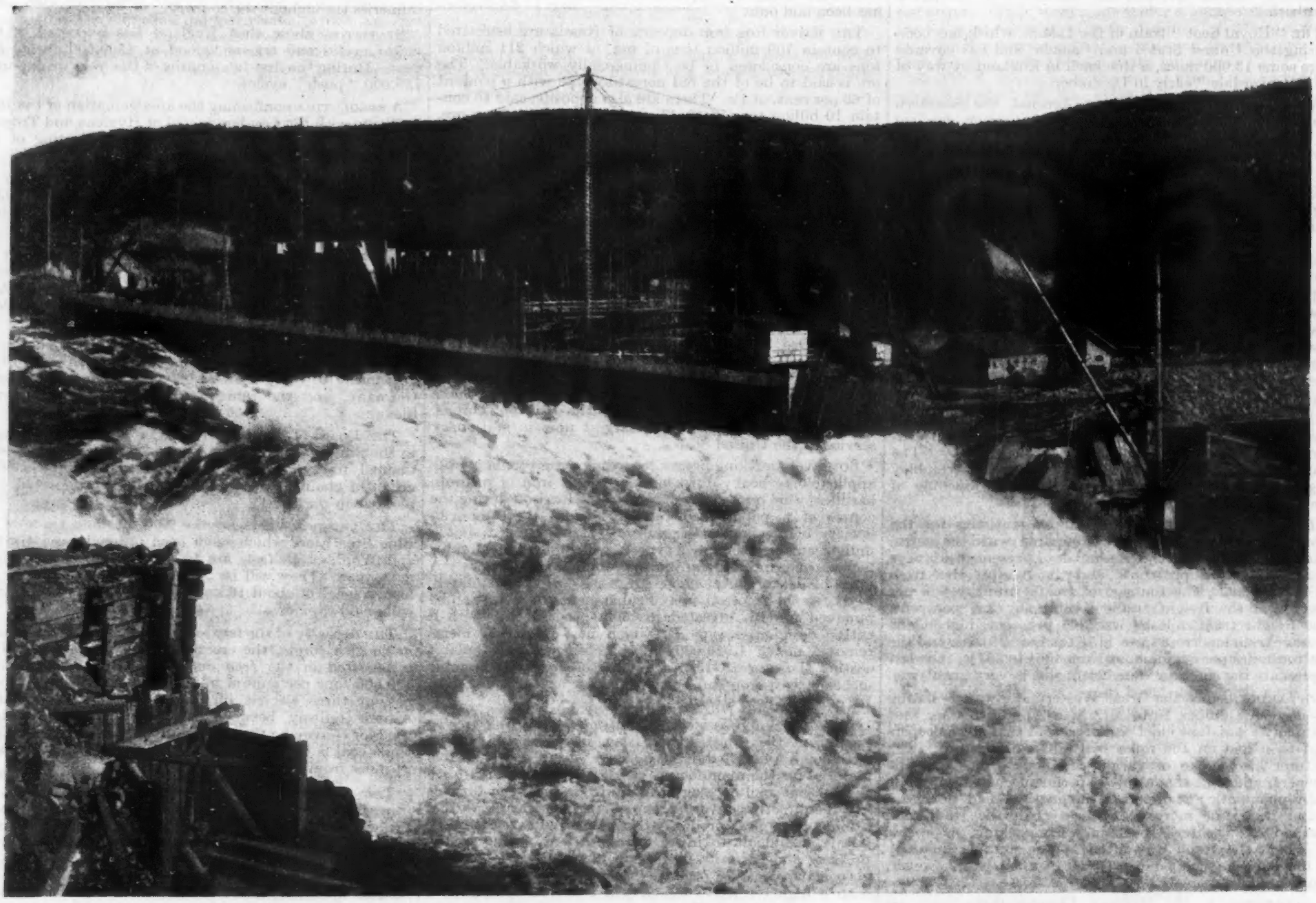
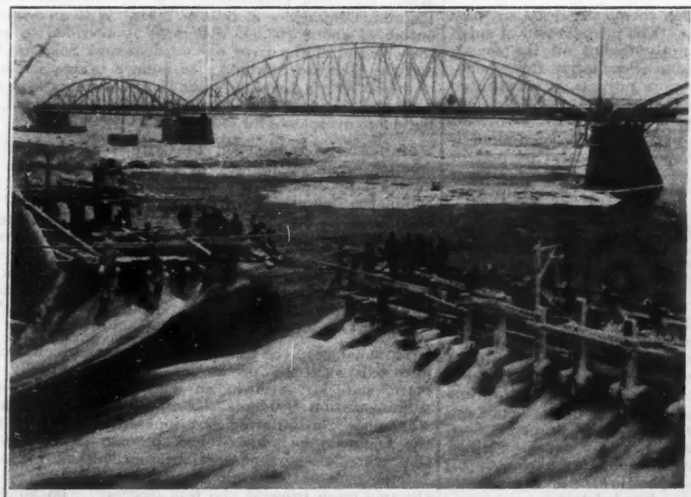


FIG. 42—THE HAMMARFORSEN FALLS SHOWING COFFERDAM NO. 1 DURING FLOOD OF 1926



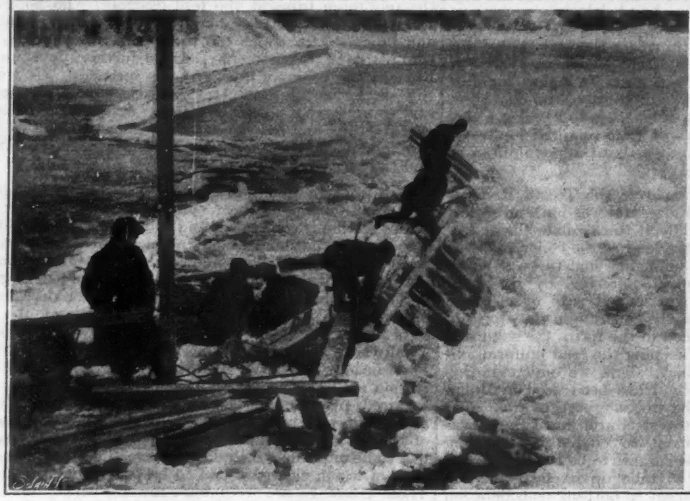
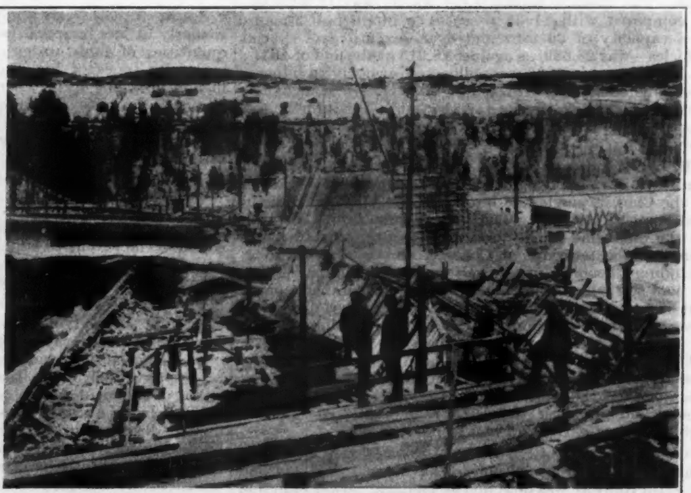


FIG. 43 (ABOVE)—TRESTLE TYPE COFFERDAM NEARING COMPLETION

FIG. 44 (BELOW)—COFFERDAM NO. 1 AROUND POWER STATION



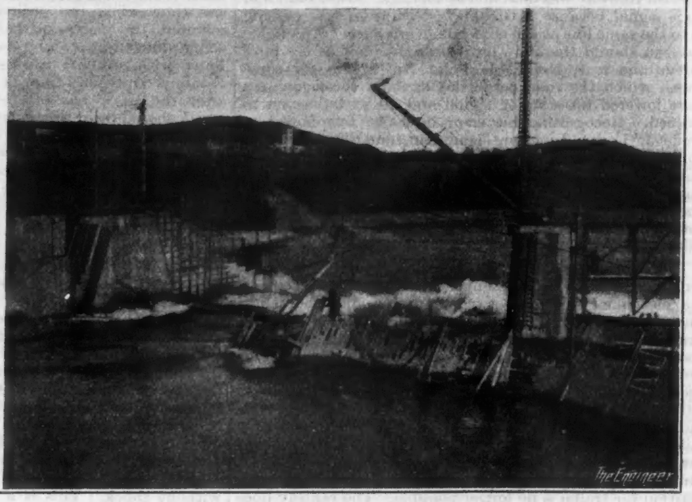


FIG. 45 (ABOVE)—SCREEN DAMS AND TRESTLE COFFERDAM

FIG. 46 (BELOW)—REMOVAL OF TRESTLE COFFERDAM

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STEEL RESEARCH.

Last week a small conference on Steel Research took place in London. It was called by B.E.A.I.R.A. and the National Federation of Iron and Steel Manufacturers, and its purpose was to ensure that enough money would be forthcoming to continue the research into steels for use with high pressures and at high temperatures which has been proceeding for several years. The minimum sum required is ridiculously small when the importance of the investigation and the size of the industries affected are borne in mind. It amounts to no more than £1500 a year for three or four years. If the industry will provide that little sum, then the D.S.I.R. will find a like amount. It is to be presumed that £3000 is held to be sufficient for the prosecution of the research, but the rapidity with which results can be attained depends upon the funds available, and it is hoped that much more than the minimum which is necessary to secure the full D.S.I.R. grant will be subscribed. The impression left by the conference is, we are glad to say, that the contributions will exceed the minimum, but some of the promises made were rather vague, and at this stage it is impossible even to guess at the total income which may be put at the disposal of the research workers.

We have said that the sum which the steel industry is invited to subscribe is ridiculously small. It is so small that one wonders why it should have been necessary to call a conference to get it. We would have expected that a mere written request to steel makers and users would have met with an immediate response which would have more than satisfied the necessities. Badly as our steel firms have been hit by the depression, we find it hard to believe that even the weakest of them cannot find a ten or twenty-pound note for an investment so rich in promise. Their avowal of inability to spare so small a sum is so incredible that we may be forgiven for suspecting that excuses of poverty, when they are made, really cover a disinclination to support the research. That disinclination may spring from several sources. It may be held that the research is not worth while at all, or that it is being carried out in the wrong way, or that individual research is better than co-operative research, or that the firm is able to provide the desired material already even if its competitors are not, or, finally, it may spring from unscientific-mindedness. It may be of some interest to consider these objections in a little detail, but as far as most of them are concerned, the answers will be found in the report of the conference which we print on another page. There our readers may find good arguments for the contention that the research is really worth while. Sir Alfred Ewing, who was in the chair, showed with that simplicity of which he is a master, that the further progress of the steam engine depends almost entirely on the discovery of a material which will stand much higher pressures and temperatures than our present steels will tolerate without creeping. That is not a matter which concerns individual firms of steam plant manufacturers alone. The prestige of the country —an invaluable trading asset—is also affected. If some other nation makes the discovery first it will assuredly gain an advantage, both because of its ability to provide the necessary material and by the enhancement of its reputation. We can imagine that those who believe that the days of steam are numbered will retort that the internal combustion engine is not affected by the research, and that, therefore, it is hardly worthy supporting. But, apart from the fact that further progress of the oil engine, and particularly of the internal combustion turbine, may hang upon the availability of the desired material, the fact remains that for many years to come steam will hold its position and the production of steam plant will be a national asset. Furthermore, as Mr. Grant pointed out, it is not the steam engineer alone who is asking for a new steel, but chemical engineers need it for plant employed in the cracking of oils and the hydrogenation of coals, both subjects of immediate interest to the maker and user of internal combustion engines. Thus, from whichever side we look at it, the discovery of the new steel is nationally desirable. With the objectors who criticise the nature of the research and its slowness in providing results, we leave Dr. Rosenhain to deal. He showed that it involved the performance of a vast number of experiments and tests, and whilst he admitted that a more systematic method might be desirable if time and expense were of no moment, he saw no alternative to the trial-and-error method, which was being pursued. The question of individual as opposed to co-operative research is one much more difficult to handle. Firms point to their own successes, and claim that what they have done by themselves in the past is evidence of what they can continue to do. It is impossible not to sympathise with them; not to feel that a firm which has the foresight and the energy to carry on expensive investigations should get some direct benefit from them. Many companies take this attitude; they do not believe in Research Associations, and will not contribute to their costs. Several of our leading steel makers are already at work on this very question; they seem to be on the verge of success; admirable steels, which very nearly satisfy the requirements, are already available; it needs but a little more to reach the very goal at which the associated research is aimed. On what grounds can these people be expected to provide funds for work which may anticipate the results which seem almost within their grasp? That is an extremely difficult question to answer. The only plea is one of national interest, and through the national interest the interest of every individual. It must be accepted as a possibility that the co-operative research will reach the desired end before any one of the individual researches, or it may lay a scientific foundation on which further advances may be prosecuted. If it does either of these things the whole steel industry of the kingdom will reap advantage and every individual firm, even though it be not a maker of the new material, will benefit. That is an important point. It is not the steel makers alone who will reap advantage from the wished-for discovery, but every firm whose business is affected by the use of the new material. The boilermaker, the steam pipe maker, the turbine builder, even the electrical plant manufacturer, all stand to gain by an improvement of steel products. This fact is well recognised in some quarters, but perhaps some companies which have not considered it may, hitherto, have been inclined to withhold contributions on the ground that the matter was not one in which they were interested. May we hope that, for the good of the industrial welfare of the country as a whole, they will review their attitude. Finally, there is the indifference of those firms which are not scientifically-minded. Even at this day such firms are not rare. They look with suspicion on scientific activities, and refuse to give them financial support. Their attitude in many instances is quite comprehensible. Their industry is not conducted amongst scientific people, and the people to whom they sell are satisfied with the product offered to them. They dread rather than welcome the disturbance which science in its progress may cause, and are only to be moved out of their complacency by the successful competition of more enterprising manufacturers. It is difficult to bring effective argument to bear on firms which are entrenched behind present success. But their position is being gradually weakened by the development of Research Associations and the activities of the D.S.I.R. If nothing else could be claimed for that Department, we should have to allow that it is performing the function of an educational body and that it is causing, slowly but surely, more scientific-mindedness amongst manufacturers.

We have endeavoured to present a few arguments in support of those much more ably advanced by the speakers at the conference. We trust they may do a little towards loosening the purse strings of those who have so far not contributed to the research. Industry is on the mend. The pendulum is swinging in the right direction at last. A small impulse now will propel it on its course. If tomorrow or the next day the wanted steel could be found, who knows what impetus it might give to the revival, who knows how much it might do to increase Great Britain's competence to defy the competition of other nations? The sum required is so small by comparison with the potentialities which lie in a successful discovery that the steel industry itself and collateral industries should find it four or five times over. May we suggest to those who are not actually opposed to co-operative research, but who from no more than indifference, have not contributed towards the expenses that, even if it is nothing more, it is a sporting venture on which a few pounds may be wisely risked.

Water Survey.

Among the reports considered at the Leicester meeting of the British Association in September last was that of a committee appointed after the York meeting of the Association in 1932 to inquire into the position of inland water survey in the British Isles, and the possible organisation and control of such a survey by central authority. The report of this committee, whose chairman was Vice-Admiral Sir H. P. Douglas, formerly the Hydrographer of the Navy, has just been issued as a British Association reprint (No. 31). It contains, in addition to a general description of the present state of water conservancy and survey in Great Britain, a series of appendices prepared by individual members of the committee and others on existing survey organisations and records in this country and abroad. It is recalled that demands and suggestions for a survey of the water resources of the country, and for a central water authority, have been made on many occasions in the past, and the report draws a clear distinction between an organisation for carrying out a water survey and a central authority or National Water Board for the administration and control of water resources. It is with the former only that the committee was directly concerned. A Joint Select Committee of both Houses of Parliament in 1910 expressed the opinion that there was need for a comprehensive survey of the water supply of the country, and, in 1921, the Board of Trade Committee on Water Power Resources, in its final report, recommended the establishment of a Water Commission for certain purposes. The passing of the Reservoirs (Safety Provisions) Act, 1930, and the establishment of Catchment Boards under the Land Drainage Act, 1930, again drew attention to the subject as a matter of immediate urgency, particularly as regards the gauging of streams and rivers to provide reliable data on which to base estimates of flood flows. One result of these enactments was the appointment by the Institution of Civil Engineers of a Committee on Floods to whose first report we recently called attention in these pages. The discussion at the York meeting of the British Association last year indicated a unanimous opinion in favour of the setting up of a national organisation for water survey.

The scope of a water survey necessary to meet the requirements of civil engineers and others interested in water conservancy should, in the opinion of the Committee, include observations and measurements and the preparation of continuous records in standard form in connection with rainfall, surface storage and flow, and underground storage and flow—in conjunction, in each case, with the physical and geological characteristics of the area. The British Rainfall Organisation, now a Department of the Air Ministry, which has grown from small beginnings as a private enterprise, provides the indispensable information as to rainfall on which engineers have hitherto had largely to depend for water-flow data. There is, however, no such existing department or central organisation to deal with direct hydrological measurements of the amount of water derived from rainfall. The Committee has considered the various systems of providing hydrometric data adopted in other countries, seeking some useful guidance from their example and experience, rather than a model which can be copied, since the conditions differ very materially. For instance, irrigation, which is vital in some countries, is of minor importance in Great Britain; hydro-electric development is a necessity in many countries, floods on British rivers do not compare in magnitude with those experienced in some parts of America; and in many cases there remain in other countries very extensive water resources as yet undeveloped. In Great Britain, on the other hand, the predominant interest is the ever-increasing need of public water supply for domestic and trade purposes. Second only to this in importance are the problems of drainage, floods, motive power, navigation, and fishing. Though the organisations of other countries, therefore, do not afford a model, their experience, particularly that of the United States, points to two important principles: (*a*) That the investigational activities of a survey should be segregated from those related to construction and administration, and (*b*) that continuous and reliable records can be collected only by the State. If these principles be accepted, as in the opinion of the Committee they should, it necessarily follows that the organisation of a water survey must be a national undertaking. The ideal to be aimed at for Great Britain, therefore, is a Government department (or section of a department) working as a central hydrometric authority in the closest co-operation with the Rainfall Organisation and the Geological and Ordnance surveys, and independent of any interest concerned with the use or control of water. These views of the Committee are embodied in the conclusions set out at the end of the report, and full consideration has been given to the steps by which the work of the survey could be most expeditiously begun. The Committee has formed the opinion that it would not be feasible in the first instance, under present conditions, to move for the immediate establishment of an organisation to be financed by public funds, but rather that a beginning should be made in a comparatively small way, financed by subscriptions from individuals and bodies interested, with the prospect of being ultimately incorporated in a Government department. This cautious attitude on the part of the Committee is, we think, one which will meet with general approbation. From the small beginnings suggested, there may be evolved in time a valuable and widespread service commensurate with the Rainfall Organisation, which, our readers will remember, was for nearly sixty years carried on as an unofficial organisation, and was rightly described by the retiring director, Dr. Mill, when its records were handed over in 1919 to the State, as "having no parallel in any country."

There is no doubt that the position of inland water survey in the British Isles is at present far from satisfactory, and that some systematic survey of the water resources is urgently required. The comprehensive examination of the matter by the Committee emphasises this need, but no statement in general terms is likely to be effective in the absence of some definite proposal in regard to future procedure, and, with this in view, the Committee approached the Council of the Institution of Civil Engineers with the result that it received an intimation that the Council will be prepared, if it is so requested by the British Association, to appoint a committee to investigate the feasibility of carrying out the objects outlined in the report on a self-supporting basis. We understand that such a request has now been made by the British Association. The Floods Committee of the Institution has already drawn attention in its first report to the paucity of available records in the British Isles of river and stream gaugings and to the desirability of an organisation for inland water surveys. The setting up of an Institution committee to deal with this problem of organisation seems to us to be the most practical step, which, in the circumstances of the present time, could be taken.

Literature.

Elements of Industrial Heat. Vol. I. By John A. Randall and J. Warren Gillon. London: Chapman and Hall, Ltd. 1933. Price 16s. 6d.

As a first textbook on heat for engineering students, this volume is to be commended. The aim of the authors has been to provide, as a preliminary to any subsequent study of thermodynamical science, a good grounding in those elementary facts and principles which are sufficient for simple calculations. This we believe to be a sound educational procedure. One does not begin to instruct a boy in arithmetic by teaching first the theory of numbers, nor to inculcate the laws of grammar before he can read and write with fluency. Similarly, the study of thermodynamics is best based on a previously acquired facility in manipulating figures concerning the simpler phenomena of heat. There are, indeed, as every engineer knows, few practical problems in connection with heat of which an adequate solution may not be obtained with no more than a knowledge of fundamental principles and a little simple arithmetic. It is essential, however, that the knowledge shall consist of a real understanding, and that it shall be expressible in figures with that readiness which only familiarity can give. The methods, perhaps, may be wanting in that directness or academic elegance which a fuller knowledge of thermodynamical theory would provide, but the results will be just as serviceable.

These remarks must not be taken to imply that the present work goes far enough to satisfy the needs of the ordinary engineer, for it does not, nor does it pretend to do so. It is an introductory textbook and nothing more. But it certainly gives the student a start in a practical direction by its constant implication, enforced by many hundreds of examples and exercises, that the object of his learning is to be able to arrive at numerical results. It opens with a chapter on Temperature, Heat and Energy. The authors then discuss in turn calorimetry, the effect of heat on solids, liquids and gases, conduction, convection and radiation. A chapter is devoted to Fuels and Combustion, and another to the Properties of Air, with particular reference to air containing moisture. The final chapter deals with Energy Diagrams, and covers isothermal and adiabatic expansion, entropy and the Mollier chart. The Carnot cycle and the Second Law of Thermodynamics are not mentioned. The discussion throughout is elementary and the very minimum of mathematical knowledge is assumed. For example, the formulæ for the work done in isothermal and adiabatic expansion are given without proof, a footnote explaining that their formal derivation would require "more mathematical treatment than the scope of this text permits." Again, with the idea, presumably, of keeping even formulæ to the strict minimum, the student is taught to arrive at the temperature due to an adiabatic compression by the indirect way of first calculating the change in volume due to the change in pressure, and then finding the temperature from the Equation of State.

In all elementary textbooks such as the present one we think that beginners should be explicitly warned against the mistake of confusing the work required merely to compress gas to a given pressure in a cylinder, and the work which has to be done by a machine that has both to compress and to deliver it. The work of adiabatic compression alone is, of course, correctly given by the formula $(P_1 V_1 - P_2 V_2)/(n-1)$, which represents the area of the part of the indicator diagram lying under the compression curve. The authors certainly allow this fact to be inferred from their diagram, but most unfortunately they themselves fall into the error of employing the above formula in a calculation purporting to show the student how to obtain the work done by a compressor which has to deliver the air under pressure in the usual way. This process would, of course, require n times the power given by the formula. The slip is certainly one that needs correcting in any subsequent edition of the book. At the same time, the formula No. (49) on page 195 should be put right, besides being reversed in sign to conform to the alternative expression, to which it is said to be equivalent. These are the only two errors we noted, apart from a statement that Watt's experiments on the power of a horse were carried out in the seventeenth century.

The authors are to be complimented on expressing themselves clearly and in good English, an art in which most technical writers of the present generation fail so lamentably. They have therefore produced a book which is not only agreeable to read, but which is just the kind likely to be helpful to the apprentice or private students without mathematical knowledge. To such we cordially commend it, though with a certain regret that it does not carry them just a little farther, because the second volume which is promised will apparently be devoted to actual power plant machinery.

Office Administration for Manufacturers. By R. A. Mills, A.M.I.E.E., A.M.I. Mech. E. London: Sir Isaac Pitman and Sons, Ltd. 1933. Pages 408. Price 10s. 6d. net.

Before offering any comments on this book, it might be well briefly to indicate its general scheme. There are five main parts, of which the first, dealing with the General Office, consists of four chapters, which comprise the postal organisation, inquiries and quotations, orders, and finally publicity and price policy. The second part is devoted to the Works Office, again subdivided into four chapters, one being given to each of the following subjects; the production office, the inventory, costs, and buying. Part III. is special to the Drawing-office; and Part IV. to Accounting, a section in which is included a chapter, contributed by Mr. F. Rumsey, A.C.A., entitled "The Prevention of Fraud and Irregularities." Part V. handles the important item of Management, a separate chapter being allowed for statistics, for statistical graphs, for budgeting, and for market analysis respectively.

Mr. Mills emphasises the importance of organisation by pointing out that the overhead expenses may amount to three or four times the actual value of productive labour and material. We quite agree, and yet are convinced that many firms exist which, when confronted with the problem of introducing economies, almost instinctively begin with a suggestion to reduce the pay of employees, a consideration which might well come last.

It would be difficult to read a treatise on Administration without finding much food for thought, discussion, and criticism. As coming within the last category it is certainly desirable to draw attention to what may be regarded as serious omissions.

The author rightly preaches the necessity for close co-operation between the various activities of an organisation, but he does not clearly show us what he considers the relative importance of different functions, yet in the case of functional organisation, which he apparently has in mind, it is essential definitely to state the exact relationship that exists between the sections. This can very conveniently be explained by means of a "family tree," branching down from the managing director or general manager, with all the officials who are found on the same line horizontally held to be of the same administrative value as one another.

Again, it has been frequently affirmed that the success of an enterprise is largely dependent upon the maintenance of a well-organised estimating department, but on this side of the business the author is remarkably quiet. He certainly fully describes the method of making quotations, but it cannot be gainsaid that this is the easier part, and a satisfactory scheme for building up estimates for new work is a *sine qua non* in office adminstration. Similarly, a well-considered rate-fixing branch must be included in any modern system, and it is felt that Mr. Mills would be well advised to add a section on this subject, which at present he somewhat cavalierly brushes aside, in the chapter on the cost office, with the remark that "a ratefixer is an absolute necessity." It is to be hoped that he does not regard the ratefixer as part of the costing organisation.

We cannot let pass unchallenged such assertions as that "the accepted term in which to deal with overheads for estimates is as a certain percentage of direct labour." Though this may be one way, it is by no means the best, and many up-to-date engineering works are now using the machine-hour-rate method, which, as its name implies, is based on the hours that the machines work, and is not directly connected with labour charges.

It is suggested that no office administration is complete in a modern undertaking without a section set apart for dealing with problems of *personnel*, and it is hoped that notice will be taken of this in future editions.

The title of the last part of this book appears to be rather misleading, for should a busy manager pick it up, turn to the section entitled "Management," and scan it rapidly through, he would gain the impression that the author's conception of management was statistics and more statistics, graphs and more graphs! Now statistics, especially when rendered graphically, are invaluable assets from the managerial point of view, and Mr. Mills' treatment of the subject, as well as that of budgeting and budgetary control, is most helpful, but it should not be forgotten that half the remainder of his book is also concerned with the problem of management.

The foregoing criticisms must not be taken as evidence that this book is not to be recommended, but rather the reverse, for a constructive and suggestive work of this nature provokes discussion, and we are sure there are few who would not derive some benefit from a study of "Office Administration for Manufacturers."

Effect of High Winds on Grain Sheds.

By J. D. W. BALL, Assoc. M. Inst. C.E.

DURING the present century many experiments have been carried out at the National Physical Laboratory and elsewhere to determine the effect of wind on structures. Results recorded by Dr. Stanton indicated 91 miles per hour as the maximum velocity to be anticipated at the Tower Bridge site, equivalent to a maximum pressure of 27 lb. per square foot. These experiments at the Tower Bridge also indicated that, contrary to popular belief, the maximum pressure at any point is little or no greater than the maximum average pressure over a large area. The late Sir Benjamin Baker, observing that windows were not blown in by high winds, determined the breaking point of ordinary glass windows, and, from the results obtained, estimated that they would not bear a heavier pressure than 30 lb. per square foot.

It is interesting to compare these results with known cases of failure during violent storms, of sheds of light construction, used for the storage of grain in bags. In some of the stations of the Argentine Railways crossing the wheat and maize zones shed accommodation is required, covering a total floor space of 10,000 square metres or more, and in order to provide storage on this scale the sheds must for reasons of economy be of the very lightest construction and easily dismantled, as the variations of acreage under wheat or maize sometimes necessitate the removal of a shed from one station to another.

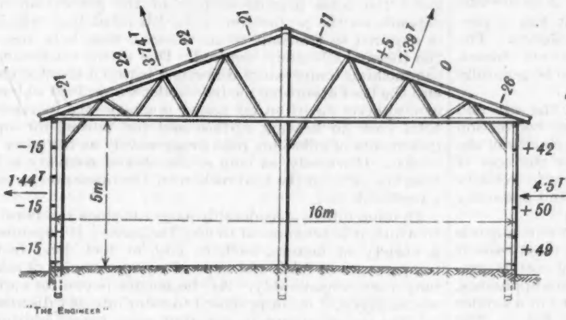

Fig. 1

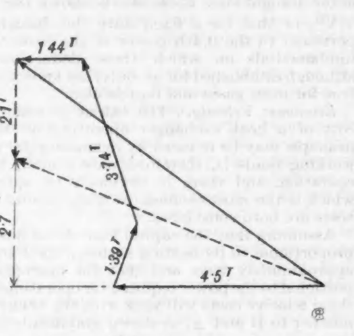

Fig. 2

A cross section of a usual type of grain shed is illustrated in Fig. 1. Sheds of this type are 16 m. wide and from 40 m. to 100 m. in length. The roof trusses are 4 m. apart, and are constructed of pitch pine, with 6in. by 3in. rafters, a pair of ties, each 6in. by 1½in., and diagonals 4in. by 3in. The trusses are carried on three 9in. by 3in. pitch pine columns, with hardwood bases. The purlins and side framing are 4in. by 3in., roof and sides being completely covered with galvanised corrugated iron sheets, secured with hammer-driven galvanised iron screwed nails, about 2½in. long and No. 14 gauge. The only openings are sliding doors and ventilation openings under the eaves. In August or September, when the equinoctial gales are at their height, it is not unusual for sheets to be loosened. Sometimes sheets and purlins are torn from the leeward side of the shed and from the leeward side of the roof, and carried away considerable distances, while many cases are on record of sheds being completely destroyed.

Experiments by Dr. Stanton on models of roofs were carried out with wind velocities varying from 10 to 20 miles per hour, equivalent to a maximum pressure of less than 1½ lb. per square foot. The suction on the leeward side of a roof with a 30 deg. slope and on the leeward side wall was never more than half the maximum pressure, but it would appear from the damage caused to the grain sheds that with stronger winds the effect of the suction on the leeward side is equal to, if not greater than, that of the pressure on the windward side.

An ordinary 8ft. corrugated iron sheet, covering an area of 13·7 square feet, has nine nails passing through it, but as four of these help to secure adjoining sheets, and each of the four corner nails help to secure three other sheets, each sheet is actually held down by four nails. In other words, the rows of nails are 3ft. 9in. apart across the roof and 11in. apart along the roof, so that each nail secures an area of 3·4 square feet. To extract one of these nails requires a steady pull of about 280 lb. Four nails should therefore require a force of 1120 lb. to extract them, which, divided by 13·7 square feet (the area covered by one sheet), indicates that a suction of 82 lb. per square foot would be required to loosen the sheets. The weight of the sheets and purlins is 2·5 lb. per square foot, so that the suction caused by the wind, when sheets are lifted, would appear to be equivalent to a steady pull of about 84·5 lb. per square foot.

The 4in. by 3in. purlins in continuous spans of 13ft. are frequently broken during severe storms. These purlins would be expected to break with a bending moment of 24 inch-tons, which, allowing for complete continuity, is equivalent to 1·85 tons per purlin, or 85 lb. per square foot. The suction has also to counteract the weight of the sheets and purlins, making a total of 87·5 lb. per square foot. If some sheets are loosened during a heavy wind, while others hold, any one purlin may have to resist the suction on a larger area than 13ft. by 3·75ft., so that the breakage of some of the purlins is no proof that the suction has reached this high figure of 87·5 lb. per square foot. Similarly, if one or more nails do not hold, there is an additional pull on those which do. Except in the outside lines, however, each nail is surrounded by eight others, so that the failure of one nail should not greatly increase the pull on the other nails.

In measuring the steady pull of about 280 lb. required to extract a nail, it is to be noted that with about half that pull a very slight jerk will loosen the nail, and this is an additional reason for doubting if the suction on the leeward side of a roof ever reaches such a high figure as 84·5 lb. per square foot. In Dr. Stanton's experiments on model roofs with winds of comparatively low velocity, the suction on the leeward side of a roof of 30 deg. slope never reached 50 per cent. of the maximum pressure on the windward side. Even if this maximum pressure is taken at as high a figure as 50 lb. per square foot, the suction would be less than 25 lb. per square foot, but, judging by the damage so frequently noted on the roofs and sides of grain sheds, the suction, if of this order, is evidently of such a violent nature that it must be considered as equivalent to a steady pull of very much more than 25 lb. per square foot. When a shed is only partially damaged, it is rare to find purlins broken on the windward side wall, which indicates that the direct pressure is of lower intensity, or that the damage caused by suction on the leeward side is possibly due to a proportion of the nails giving way and putting additional load on the purlins in which the nails have held.

Assuming that the distribution of pressure and suction, with high winds producing a maximum pressure of 50 lb. per square foot, is proportional to that obtained on models in a wind stream of low velocity, this distribution would be as shown in Fig. 1. With a suction of 22 lb. per square foot on the leeward side of the roof, the stresses in the members of the trusses are reversed, the rafters being in tension and the ties subjected to compression, but the stresses reached are not sufficiently high to cause failure.

The resultant forces on the roof and sides of one bay of the shed are also shown in Fig. 1, and are combined in Fig. 2, showing that there is a resultant force of 8·5 tons acting on each bay of the shed, inclined at an angle of 36 deg. with the horizontal, tending to lift the shed from the ground. The weight of one bay of the shed is only 2·1 tons, and the effect of this is also shown in Fig. 2, but to counteract the lifting effect of the wind each of the three columns must in addition to the weight provide an anchorage of nearly 1 ton, and failure to do this, especially when the bases are beginning to decay underground, probably explains the occasional complete collapse of a shed.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HEAT LIBERATION AND TRANSMISSION IN BOILERS.

Sir,—While I am in agreement with your report of the meeting at the Institution of Mechanical Engineers on the 17th inst., that the discussion on the paper which was then read was disappointing, I feel I must make some explanation to account for the way in which the paper was read.

Shortly before the appointed time I was informed that there would be allowed fifteen to twenty minutes for the reading of the paper, and in the time available it was impossible to compress the material contained in it into the number of words which could be spoken in that period; in fact, it is questionable whether it could have been done at all.

While appreciating the probable effect on the minds of those who had not had an opportunity previously to study the advance copy, it seemed that the only thing to be done was to read such extracts as appeared to make a more or less continuous line of argument.

As far as concerns at least one of those present, this attempt appears to have been a failure; but even now, after reviewing the paper, it does not seem possible even to have referred to the passages which were omitted and to make the matter referred to therein intelligible in fewer words than those used in the paper as it appears.

One is perhaps entitled to expect that anyone who goes to the trouble of attending a meeting of this kind will have made himself familiar with the matter which is to be discussed, by obtaining an advance copy of the paper.

E. W. Robey.

London, November 24th.

THE ENGINEER SALESMAN.

Sir,—The letter under the above heading, appearing in your issue of November 24th, is of considerable interest; the writer apparently is referring to home trade. From over twenty years' export experience, it is a matter of surprise to me that so few engineering firms employ engineers with commercial experience. I have found that if a quotation is asked for involving technical knowledge, the London office invariably has to refer the matter to the works. The engineer with commercial experience will see opportunities for increasing business which are completely missed by the purely commercial man. Undoubtedly the employment of the commercial engineer will not only lead to greater efficiency, but is essential for present-day conditions.

Export.

London, November 28th.

ROAD ACCIDENTS.

Sir,—May I, as one who has had considerable experience in driving on the Continent, where speed is and will remain, in the opinion of many, excessive, point out that the statistics published in *The Times* some time ago showed that the casualties in Paris were less than they were in London per thousand of population?

My experience convinces me that this is due not only to the crossings provided for pedestrians in which the latter have right of way, but also to the navigating rules adopted in France (and twelve other European nations), which, at cross roads would involve our giving priority to traffic coming from the left, instead of the convention here of giving way to traffic coming from the right.

The advantages of looking leftwards at cross roads are briefly these:—

It enables a driver to anticipate the movements of pedestrians about to step off the pavement near which one is driving.

It does not distract the attention from notices and warnings which are posted up on the left side of the road.

In emergency it gives one the width of a pavement and half the width of a road to pull up in after the priority traffic has been sighted, whereas looking to the right only gives about a pavement's width. This is of great importance in the case of encounter with the type of driver whom no amount of law and fines prevents from charging a cross road.

R. Douglas Archibald.

Devonport, November 25th.

OIL-ENGINED TUG FOR PERU.

On Tuesday, November 21st, there was launched from the Lowestoft yard of Brooke Motors, Ltd., the 45ft. oil-engined tug "Corona," which has been designed and built for the tanker mooring services of Lobitos Oil Fields, Ltd., on the Peruvian Coast. A preliminary run was made after the launch and on the following day official trials took place. The tug has proceeded to Amsterdam, where she will be loaded on a steamer for delivery to Peru, *viâ* the Panama Canal. A feature of the order, which was gained in the face of keen competition, both in this country and America, was the delivery of the vessel within nine weeks. The hull has a length of 45ft., a beam of 11ft., and a draught of 4ft., and a control house is arranged aft of the engine-room casing. Suitable provision is made for heavy towing bits and hooks behind the control position, but otherwise the decks are left clear for the expeditious handling of ropes and mooring lines. The propelling machinery comprises an 80 B.H.P., four-cylinder National oil engine, which also drives a small dynamo for lighting and auxiliary services. A 5 brake horse-power single-cylinder engine is placed in the port wing space and serves to start the main engine by means of a belt drive. The tug has a designed speed of 11 knots, and is strongly constructed and finished in a pleasing manner.

There is a rather fascinating story of a breakdown told in a paper read before the North of England Branch of the National Association of Colliery Managers by Mr. A. B. Hare. The pit at Throckley was drained by two electrically driven centrifugal pumps of 350 H.P. each. The reflux valve on one of the pumps burst, and the pump-room was flooded—on a Christmas Eve. The pump motors were put out of action by the flooding, but fortunately there was still in working order a steam pump fifty years old, that had not been used for ten years. It was got under way, and although it had to pump against a head of 350ft., cleared the pump-room, so that the electrical equipment could be repaired. The day after Boxing Day normal pumping was resumed.

Heat Liberation and Transmission in Large Steam Generating Plants.*

By E. W. Robey, M.I. Mech. E., and W. F. Harlow, A.M.I. Mech. E.

(*Concluded from page 532.*)

The Transmission of Heat.

General Principles.—At one time the view was held, and to some extent still persists, that the sole criterion of the capacity of a steam boiler to absorb heat depends on the extent of its heating surface. It is now well known that the amount of heat a given area of surface will transfer depends entirely on the manner in which it is arranged. Steam generators are successfully operating at the present time in which the fuel is burnt in a pulverised form which permits of the combustion chamber being entirely surrounded by water-cooled surfaces. In certain of these units as much as 63 per cent. of the total heat liberated by the fuel is transmitted to the steam and water by radiant heat. This arrangement presents certain definite advantages, inasmuch as the radiant heat surface serves the two-fold purpose of absorbing heat and forming furnace walls capable of effectively resisting the high temperature in the combustion chamber.

In other types of boilers, where refractory walls are employed, the heat is transferred almost entirely by convection. It is obviously impossible to transmit more than a portion of the heat to be received by an efficient steam boiler by radiation, and therefore much of the heat transmission at the lower end of the temperature range must be effected by convection. Even in designs such as those mentioned above, where more than half of the total heat is transmitted by radiation, the radiant heating surface is a comparatively small proportion of the total. This is because the rate of transmission by radiation is extremely high, due to the large temperature difference in the region in which this effect takes place. On the other hand, due to the comparatively low temperature differences prevailing where convection operates, the convection surface forms the major part of the total surface in the boiler. Even with the maximum amount of radiant heat surface the convection surface still represents more than 80 per cent. of the total. Therefore, in considering the size and cost of a steam generating unit from the viewpoint of the heating surface it contains, the extent of the convection surface is by far the most important factor.

Although the laws which govern the transfer of heat by radiation in boiler furnaces are somewhat obscure, it can be said that those governing convection heat transfer have now been definitely established, and can be applied in a fairly satisfactory manner to the problem of boiler design. An important difference between radiation and convection is that the latter effect can always be increased by increasing the speed at which the gases pass over the surface. Assuming a steam generator designed so that the furnace is completely water-cooled by tubes forming part of the boiler circulation system, one effect of reducing the furnace dimensions and increasing the rate of combustion over the fire bed would be to reduce the amount of radiant heat surface, and at first sight this might be thought a disadvantage.

It will be clear that with a smaller chamber the radiant heat surface will still receive the same total amount of radiant heat but at a greater intensity, as the surface is nearer the source of the radiation. It will therefore be more efficient. Quite apart from this, however, it is not disadvantageous to compensate for the loss of radiant heat surface due to the reduction of furnace volume, by an increase of convection surface by an amount dependent on the adopted gas velocities. Not only is the convection mode of heat transfer the most important effect in most boilers, but it is also the manner in which the heat is transmitted in the economiser and air heater.

Laws of Convection Heat Transfer.—That the amount of heat which a certain area of heating surface is able to receive from a moving gas depends on the speed with which the gas moves over the surface was first pointed out by Osborne Reynolds in 1874. More recently, in 1909, Dr. Nicolson showed the enormous advantage that could be gained by passing flue gases at higher velocities over the heating surface of steam boilers. Although little attention was paid to this for many years by practical engineers, the principle that the heat transfer is a function of the velocity is now widely recognised, and more recently many investigations have been carried out to establish the actual relationships that exist. These have resulted in numerous complex and somewhat divergent conclusions, but summarising the various opinions expressed the authors consider that the relationship

$$K=C_1V^{\frac{3}{4}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where K is the rate of heat transfer per unit area per degree of mean temperature difference between gases and surface, V the mass velocity of the gases moving over the surface (weight of gas per unit area of cross section of gas stream per unit time), and C_1 a constant, is of sufficient simplicity and accuracy to be the most suited for practical purposes.

Unlike the heat received by radiation, heat cannot be transferred by convection without some expenditure of energy to move the heating gases over the surface to which the heat is to be transmitted. Since the heat transfer depends on the velocity, and the energy loss also depends on the velocity, there must be a relationship between the heat transfer rate and the energy loss necessary to produce this effect. The energy loss is represented by the pressure drop or draught loss suffered by the gases in flowing over the heating surface, and this may be taken to vary as the product of the square of the mass velocity and absolute temperature. Thus

$$\Delta=C_2V^2T \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where Δ is the draught or pressure loss of the gases, V their mass velocity, T their mean absolute temperature, and C_2 a constant.

Here, again, some difference of opinion exists, but the authors find that the relationship given is confirmed in quite a satisfactory manner by practical results. The validity of both the fundamental equations (1) and (2) has been confirmed by the authors, not only by the operating results obtained from plants, but also by tests carried out with experimental apparatus.

Considering the significance of these relationships in the operation of heat-exchanging apparatus, it is clear that for a given extent of surface an increase in mass velocity increases the amount of heat transferred at the expense of draught loss. It is more important, however, to know the effect produced by changes of mass velocity on the extent of heating surface necessary and on the draught loss incurred for a heat exchanger that is to perform a given duty. In this case it must be assumed that a definite amount of heat is to be transmitted to or from a given quantity of fluid passing through the apparatus at a given rate.

The authors propose to take as an example a simple heat exchanger, and to assume a definite weight of air per hour to be cooled through a certain temperature range, and to ascertain the effect of varying the mass velocity V. As the total air flow is fixed the mass velocity can only be varied by increasing or decreasing the number of elements. Since the thermal duty also is fixed, all temperatures will be constant and therefore may be neglected. The length of the element will now vary, and since the friction loss through a pipe or duct is known to be proportional to its length the expression (2) previously established for draught loss must be modified by the introduction of a length factor. Thus let

$$\Delta=\text{constant } V^2L \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where L is the length of the element. From these relationships it can be shown that $H=\frac{\text{constant}}{\sqrt{\Delta}}$, or in words, that the heating surface varies inversely as the cube root of the draught loss. It can also be shown that $\Delta=\text{constant} \times V^{2\frac{1}{4}}$, or that for a fixed duty the draught loss is proportional to the 9/4th power of the mass velocity. The fundamentals on which these deductions are based, although established for air only, are known to be generally true for most gases and liquids also.

Economic Velocity.—The extent to which the size and cost of a heat exchanger operating on the convection principle may be reduced by increasing the velocity of the working fluids is, therefore, only limited by the cost of operation, and there is obviously an optimum velocity which is the most economical when capital and operating costs are both considered.

Assuming that the capital cost of the heat exchanger is proportional to its heating surface, which in most cases is approximately true, and that the operating cost is proportional to the power required for operating the apparatus, these relative costs will vary with the velocity in a similar manner to H and Δ, as shown graphically in Fig. 5. The summation of these two curves gives the total cost which at a certain velocity attains a minimum value. Obviously this velocity is the most economical value that can be adopted for any particular conditions. Since boilers, economisers, air heaters, superheaters, and feed heaters all operate on the convection principle, the above reasoning is applicable to any of these components of steam generating equipment, and although in the case of economisers and air heaters the laws given above appear to have received observance, in the case of boilers these considerations seem to have been seriously neglected. The present-day practice in boiler design is to arrange for gas velocities which result in a draught loss very little in excess of that which can be overcome by natural means, notwithstanding the possibilities of mechanical draught; and the intensity of the latter has been governed principally by the resistance imposed by economisers and air heaters.

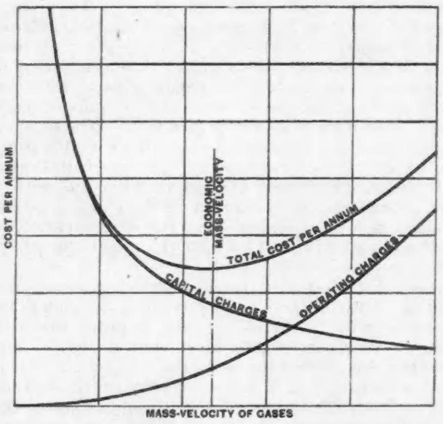

Fig. 5—*Variation of Relative Costs of Heat Exchanger with Fluid Velocity for given Thermal Duty.*

Capital charges are taken to vary as $H=C/V^{\frac{3}{4}}$.
Operating charges are taken to vary as $\Delta=C.V^{2\frac{1}{4}}$.

Applying the relationships established above to a water-tube boiler and neglecting the extent of radiant heat surface which, as already stated, constitutes only a small proportion of the whole, it should be possible to reduce the heating surface by 50 per cent. at the expense of an increase in the draught loss to eight times its normal amount. At present the usual practice is to design water-tube boilers with a draught loss of from ¼in. to ½in. of water. If the gas velocities in such boilers were increased so that the resistance through the passages was 2in. to 4in. of water the heating surface could be reduced by 50 per cent. This at first sight may appear to indicate an excessive demand for auxiliary power, but a little consideration will show that this increase is comparatively unimportant.

Considering a boiler of 100,000 lb. per hour evaporative capacity at 300 lb. per square inch pressure, 700 deg. Fah. steam temperature, and 250 deg. Fah. feed temperature, the gas quantity would be approximately 160,000 lb. per hour, or 51,000 cubic feet per minute at 300 deg. Fah. Assuming the draught loss through the boiler is increased from ½in. to 4in. of water, and that the overall efficiency of the induced draught fan and motor is 50 per cent., the power required to overcome the increase in resistance would be 42 kW. Taking a station efficiency of 20 per cent., the heat equivalent of this power expenditure would be 0·52 per cent. of the total heat input to the plant. Hence the effect of decreasing the heating surface and therefore the capital cost of the boiler, would be a loss in efficiency of only 0·5 per cent., or conversely, the advantage gained by doubling the size and cost of the boiler, thereby keeping the auxiliary power low, is merely to increase the efficiency by this amount.

In cases where fuel is cheap and the load factor low the increase in the capital cost of a steam generating unit incurred by the adoption of air heaters and economisers in order to obtain high efficiencies is frequently considered unjustifiable. In such instances it would probably be found more profitable to reduce the cost of the boiler by increasing the gas velocities and to utilise the money thus saved for the provision of an economiser and air heater, thus increasing the efficiency at no increase in cost.

In most types of boilers in common use the gas velocities are far below the true economical value, and much of the draught loss that occurs is caused by changes of direction in the gas stream and is not productive of heat transfer. To be efficiently utilised the draught loss should arise entirely from frictional resistance through the tube banks, and, since the heating surface can be reduced at the expense of draught, wasted resistance is tantamount to an unnecessary increase of heating surface. It appears that the possibilities of reducing the heating surface of water-tube boilers by using higher gas speeds which are made possible by the introduction of mechanical draught, have not been fully explored and that considerable advances are possible in this direction.

Stack Temperature.—For any given velocity of flue gases the total heating surface of the generating unit depends on the proportion of the liberated heat which it is required to transmit to the steam; that is to say, on the thermal efficiency required. Due to the continuously diminishing temperature difference between the flue gases and the heat absorbing media—boiler water, feed water, or atmospheric air (if an air heater is used)—the increase in total cost (in heating surface and fan power) for equal increments of efficiency rises progressively as the gases are cooled. Obviously, as long as the cost of recovery is less than the value of the heat reclaimed, the operation remains a profitable one.

Opinion differs considerably as to the stack temperature to which it is economical to cool the gases; it depends on a variety of factors, such as cost of fuel, load factor, temperature of feed, and type of equipment, all of which may vary considerably. As the matter is one for careful cost analysis, it is not proposed to enter into any discussion on this point, except to say that since every additional 30 deg. that the gases are cooled represents a reduction of the fuel bill by approximately 1 per cent., very considerable expenditure can be justified to obtain low temperatures.

In British power station practice the limiting temperature is generally considered to be 250 deg. to 300 deg. Fah., but in America the present trend is towards considerably higher temperatures of 350 deg. Fah. and upwards. It may be said that in most steam generating plants in this country a stack temperature of 250 deg. Fah. can be easily justified from considerations of economy, providing a suitable arrangement of plant is adopted.

Air Heaters.—The recognition of the above has led to the general adoption of air heaters, without which such low temperatures are quite impossible. Even where the desired stack temperature is considerably above this figure an air heater is usually essential, as the relatively high temperature of the feed when heated by bled steam makes it impossible to cool the gases sufficiently by the economiser alone. Further, and apart from the above considerations, air heater surface is generally cheaper to install and maintain than economiser surface, even when the lower rate of transfer in the air heater is taken into account. As previously stated, the extent to which air heater surface can replace economiser surface is limited in mechanically fired plants by the effect of the heated combustion air on the fuel bed, but the use of a large proportion of secondary air will considerably raise this limit. In general, and assuming there are no limitations to the temperature at which the air may be used in the combustion process, the greater the extent to which air heater surface replaces pressure surface, the cheaper will be the complete generating unit, providing such air heater surface is used to the best advantage.

In considering the temperature range through which it is possible to cool the flue gases by air heating, due regard must be given to the heat capacity of the air compared with that of the flue gases. Since the quantity and the specific heat of the flue gases are each greater than the corresponding quantity and specific heat of the combustion air, the rate at which the gas cools is always less than the rate at which the air is heated. That is to say, the ratio

$$\varphi=\frac{\text{temperature rise of air}}{\text{temperature fall of gases}} \text{ is always greater than 1.}$$

In an ideal plant this ratio should be about 1·1, but in practice it is usually not less than 1·25 and frequently much higher. Hence the difference between the temperature of the stack gases and the atmospheric air which exists at the cold end of the heater progressively diminishes as the air becomes heated. The heating surface therefore becomes less effective until a stage is reached where any further increase of heating surface becomes uneconomical. For the comparatively small range of temperatures through which it is customary to cool the flue gases by air heaters in plants fired by mechanical stokers this effect is not sufficiently marked to merit special consideration, but when high preheated air temperatures combined with low stack temperatures are desired, as in pulverised fuel or oil burning installations, the matter becomes one of considerable importance.

For example, assume a stack temperature of 250 deg. Fah., preheated air at 700 deg. Fah., ambient air temperature at 100 deg. Fah., and $\varphi=1{\cdot}25$. The drop in gas temperature through the heater would have to be $\frac{(700-100)}{1{\cdot}25}=480$ deg. Fah. The gas would therefore have to enter the air heater at (480+250)=730 deg. Fah. The temperature difference between the air and gas consequently would be only 30 deg. Fah. at the hot end, although 150 deg. Fah. at the cold end. The amount of heating surface necessary to effect the heat recovery under these conditions would be entirely disproportionate. In such cases a much more effective temperature difference could be maintained between the air and gases by introducing a small economiser or feed heater between two sections of air heater at a suitable point in the temperature gradient, thus reducing the heating surface to economical proportions.

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* The Institution of Mechanical Engineers—Abridged.

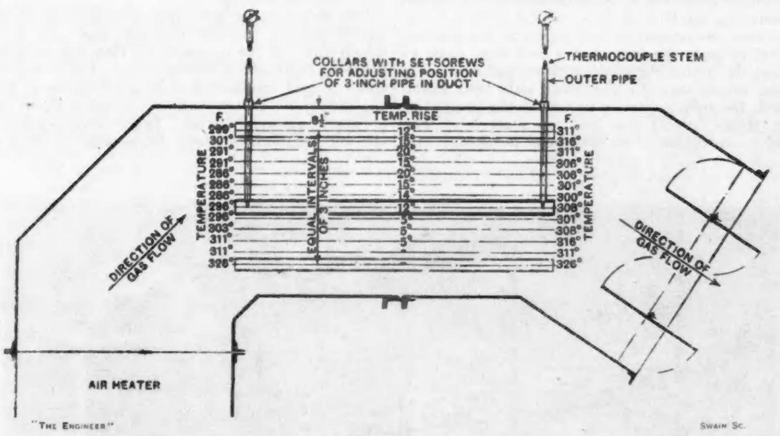
It will be obvious from the foregoing that the value adopted for φ bears an important relation to the area of heating surface of an air heater which is necessary to produce any desired temperature reduction in the flue gases, and the accurate assessment of this factor is essential if the designed results are to be realised. At first sight it may appear that the estimation of this factor is quite a simple matter, as the relative weights of air and gas are easily calculable and their specific heats well known, but experience shows that values much higher than those obtained from the above considerations are possible. Clearly, if a heater is designed on a basis of $\varphi = 1 \cdot 2$, and in practice $\varphi = 1 \cdot 5$, the final gas temperature will seriously exceed the expected figure, since the capacity of the air to reduce the gas temperature has been over-estimated.

The existence of this apparent discrepancy in the thermal balance of an air preheater has for some time been recognised, but was always attributed to a deficiency in the air quantity actually passing through the heater.

The obvious remedy was to construct plants in such a manner that no air other than that passing through the air heater could gain access to the furnace, but despite the meticulous care with which modern steam generating plants are designed to attain this end, the disparity still persisted. It was then considered that the discrepancy was due to inaccurate temperature readings, and for this reason the authors obtained extremely sensitive thermocouples by means of which radiation effects could be eliminated. These not only confirmed the figures previously found, but their greater sensitivity rendered possible accurate exploration of temperature across any section of the gas and air ducts. From these readings it was found that there appeared to be actually an increase in temperature in the gases after leaving the air heater. It was considered, therefore, that the discrepancy could only be explained by the liberation of a certain amount of latent heat in the flue gases during their passage through the air heater, and realising that the problem was one which called for expert analytical investigation, they invited Professor M. W. Travers, F.R.S., to make a research into the matter.

By the use of very exact methods, Dr. Travers showed that an increase in CO_2, in some cases a decrease in H_2, and a corresponding decrease in O_2, occurred in the flue gases passing through the air heater, and that the latent heat of combustion that would result from such changes would fully explain the discrepancy between the temperature rise of the air and the fall in the gases.

More recently the authors have carried out further investigations into the temperature rise in the gas stream leaving the air heater, by introducing a tube with thermocouples at each end, as shown in Fig. 6, thus removing any doubt that might be entertained with regard to their original figures when the duct was merely traversed. The results show that even in a distance of 7ft. the gas temperature rises by as much as 20 deg. Fah. It would appear that given the requisite conditions for the air and combustible gases to associate, combustion often proceeds in the gas stream beyond the flame, and this may take place even at temperatures as low as 300 deg. Fah.



"The Engineer" Swain Sc.

Fig. 6—*Method of Measuring Temperature Rise in Gases Leaving Air Heater.*

Tests results show that this phenomenon is quite commonly in evidence and that it is not confined to any particular make or type of air heater, boiler, or combustion equipment. The only conclusion that may be drawn from comparisons of equipment would appear to indicate its absence in oil-fired generators. In certain plants of every type there is no evidence of such action, and in the authors' view this is probably because of the prompt manner in which the combustion in the furnace is brought about by better association of the air with the combustible gases in correct proportions. It is significant that in cases where combustion has appeared to be smoky, this phenomenon has usually been evident. The apparent discrepancy in the heat balance not only occurs with air heaters, but is frequently found to exist with many economisers and undoubtedly can be explained in a similar manner.

To render the heating surface not only of the air heater and economiser, but also of the complete steam generator, fully effective, the heat should all be released before the convection process of heat transfer commences. Any heat liberated during the passage of the gases over the convection surface tends to lower the efficiency of this process. It has been a noticeable fact that in plants where secondary air has been liberally and efficiently applied an appreciable reduction has been made in the stack temperature.

Dew Point Effects.—One of the chief problems that has been encountered in obtaining low stack temperatures by air heaters has been that of avoiding the harmful effects resulting from condensation of the moisture in the flue gases on the air heater elements. No air heater will operate satisfactorily if the plates are periodically or continuously wetted whilst in operation, as not only does this cause adherence of the flue dust which obstructs the gas passages, but the combination of the moisture with the sulphurous gases in the products of combustion causes the formation of corrosive sulphuric acid, which rapidly attacks the elements. The matter is one on which misconception exists, due in a great measure to lack of exact data on the dew point temperature of flue gases. Until quite recently no reliable information on this subject was available.

Since air heaters have been introduced various means of meeting dew point trouble have been adopted, and most of these seek to remove the effect rather than the cause. Until the last year or two, no serious attempt appears to have been made to get to the root of the trouble by stopping the formation of dew.

The only attempt that appears to have been made to prevent condensation was to limit the temperature to which the gases were reduced by the air heater, as it was generally considered that condensation depended entirely on the gas temperature. Notwithstanding that in some cases dew point trouble was experienced with gas temperatures of 350 deg. Fah. and over, and that in other cases with temperatures of 230 deg. Fah. the trouble was absent, this view was still commonly accepted, and the difference of behaviour referred to was frequently explained by the virtues of the type or make of the air heater. In certain installations with which the authors were concerned a few years ago, this trouble was so acute, even with gas temperatures of 300 deg. Fah. and upwards, that it was obvious that the prevailing notions on the subject were fallacious, and a thorough investigation of the whole problem became necessary.

It was recognised, of course, that in order to maintain the plates of an air heater or any other cold surface free from moisture, it is necessary to keep the temperature of the surface at or above the dew point temperature of the gases. If the temperature of the wall of an air heater element is the mean of the temperatures of the air and gas on either side, then with the plant in question the minimum temperature would have been well above the theoretical dew point temperature. For example, with gas leaving at 300 deg. Fah. and air entering at 80 deg. Fah., the minimum plate temperature would be 190 deg. Fah. The dew point as calculated from hygrometric tables would be approximately 100 deg. Fah. (for coal with 10 per cent. moisture, 4 per cent. H_2, and 13 per cent. CO_2 in the flue gases). Nevertheless, the condensation on these air heaters was so rapid that the elements were simply dissolving away.

A closer examination of the problem showed that this accepted theory of the temperature of the wall was fallacious, because it presupposed equal rates of transfer from the gas to the metal, and from the metal to the air, which in practice do not occur throughout the element. There are several reasons why this assumption is not justifiable.

Even if it were possible to calculate the plate temperature from the relative temperatures of the air and gas, it is extremely difficult to estimate the lowest gas temperature that may be experienced because this fluctuates between wide limits.

The foregoing considerations, combined with their experience in this matter, led the authors to conclude that the only practical way to ensure that the lowest temperature of the heater elements was above the dew point temperature of the gases was to maintain the temperature of the air entering the heater at, or closely approaching, this temperature. In general, the results obtained by the application of this principle have greatly exceeded expectations, as by this means it is possible not only to prevent any deterioration whatsoever of the elements, but there is a considerable increase in heat transfer and definitely no falling off whatever of the heat efficiency, even after long service. Further, in most cases where these conditions are carefully maintained, the problem of cleaning the heater is practically eliminated. All that is necessary is a periodic blowing-out by compressed air.

Of course, these advantages are not obtainable without some extra cost, as means must be provided to increase the initial air temperature to the desired figure. Usually the most convenient method is to recirculate a portion of the preheated air through the forced draught fan, the amount necessary depending on the temperature of the air supply, the temperature of the preheated air available, and the dew point temperature of the flue gases from the particular fuel used. Obviously this involves an increased load on the fan, but the cost of this power is negligible compared with the saving in maintenance and efficiency, due to the improved condition of the heater. (Usually the heat equivalent of the total forced draught fan power is of the order of ¼ per cent. of the fuel. Assuming the recirculation increases this power by 20 per cent., the heat equivalent of this increase would be 0·05 per cent. of the heat input to the plant. This represents approximately the same heat loss that would be brought about by an increase of 2 deg. Fah. in the stack temperature. An air heater becoming dirty will elevate the temperature of the stack gases by 20 or 30 deg. in a very short time.)

If sufficient consideration is given to the arrangement of the plant in the design stage, so that the air supply to the forced draught fan is comparatively warm, the increase in fan power necessitated by recirculation will be greatly reduced, if not eliminated. The ambient air temperature in a boiler house may vary as much as 50 deg. Fah. at different points, and in the interests of the general efficiency of the unit, as well as that of the air heater, the position of the air intake should be such that the heat which must be radiated from the generating unit is reclaimed and returned to the system. As the air is introduced at a higher temperature than previously, one might imagine that this system of recirculation reduces the thermal efficiency of the air heater. In practice this is not the case, probably because the higher temperature of the air is offset by the greater quantity which is passing through the heater.

Soot Blowers.—An important consideration affecting the dew point of the gases which is often overlooked is that any steam or water used in the combustion process materially raises the dew point temperature and therefore increases the liability for moisture to be deposited, not only in the air heater, but also in the stack. The same effect is produced by the use of steam soot blowers for cleaning the boiler and economiser surfaces. The amount of steam injected into the flue gases by soot blowers varies considerably with the type of blower employed, but frequently the difficulty of keeping the boiler and superheater surfaces clean necessitates the use of an amount of steam that is sufficient to raise the dew point temperature as much as 50 deg. Fah. or more. Actually, dew point temperatures of 175 deg. Fah. and upwards have been registered while soot blowers were being operated, and precautions should be taken to see that either the air entering the heater is raised to a temperature approaching this figure, or, failing this, the air should be excluded from the air heater whilst the soot-blowing operation is carried out.

In some cases soot blowers are situated in a region of low gas temperature close to the air heater. It is possible that when steam (either superheated or saturated) is expanded to atmosphere through the soot blower nozzles, it will become wet, due to the heat drop experienced. If this moisture is not re-evaporated before reaching the air heater elements, it will be deposited, regardless of their temperature. Any water thrown out by the blower by reason of inadequate draining will, of course, act in a similar manner. In such cases the only remedy appears to be compressed air blowers; in fact, having regard to the possible ill effects of moisture in the flue gases in raising their dew point, the authors are strongly in favour of air blowers for all boiler-cleaning purposes.

FORESTRY AIDS EMPLOYMENT.

A project to transform seventy-eight square miles of forest near Colter's Landing, in the province of New Brunswick, into a model experimental forest area for the Maritime Provinces is part of a great and increasingly successful governmental co-operative scheme for solving the problem of caring for thousands of single unemployed men throughout the Dominion. The Maritime plan was made possible in the first place by the action of the New Brunswick Government in setting aside the large forest area for other than commercial purposes. The scheme is primarily and essentially a relief scheme. When the plan was formulated by the Department of National Defence in the autumn of 1932, a modest start was made with the employment of 2000 single men on the clearing and grading of intermediate landing grounds on the Trans-Canada Airway; on repairs to the old fortifications at Halifax and Quebec, and on the construction and improvement of air stations at several other points. With a steady expansion of the plan, it is now capable of employing at least 20,000 single men. At the present time the Department of National Defence is supervising projects in British Columbia on which about 7000 young men are employed. Another large forest scheme in Manitoba is providing useful productive employment. In the Duck Mountain district of that province, 50 square miles of land have been given to the Government of Manitoba for the development of an experimental forest area to provide information in respect to the important spruce forests of Northern Manitoba and Saskatchewan. Coming east into the north-western area of Ontario, a large amount of employment is provided by the clearing of the foreshore of the Lac Seul reservoir, in co-operation with the Governments of Ontario and Manitoba. This work will make available when completed an additional head of 12ft. for the English and Winnipeg rivers power plants. In this case the benefit of the work will be transmitted directly to the users of electric current. Most of the projects for the relief of single men are administered, and the works are carefully supervised, by the military district in which they are situated. For the preparation of plans and specifications, the Royal Canadian Engineers are held responsible, while the Army Service Corps provides the transportation and feeding facilities. Clothing and equipment are issued by the Ordnance Corps, while sanitation and medical attention are provided by the Medical Corps.

Steels for Use at High Temperatures

(See also page 542.)

THE following statement by the investigators of the British Electrical and Allied Industries Research Association on the results sought and achieved in the Research on Steels for High Temperatures is dated November 10th, 1933 :—

An intensive and comprehensive research upon steels for high-temperature service has been proceeding for the past three or four years under the direction and control of the Joint Committee representing the British Electrical and Allied Industries Research Association and the National Federation of Iron and Steel Manufacturers.

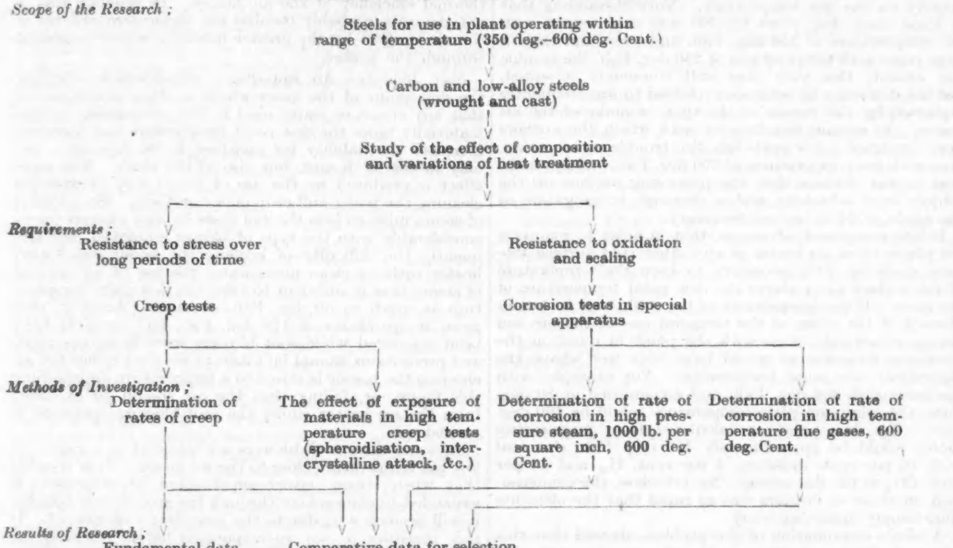
The research, which has been carried out at the National Physical Laboratory, has two main activities, viz.:—

(1) To explore the properties of various low alloy steels with a view to providing authoritative guidance in their better utilisation for high-temperature service.

(2) To examine the possibilities of improvement of selected steels by the addition of various elements considered promising.

In the case of both activities two lines of investigation are involved. These are concerned with (*a*) mechanical properties, and (*b*) resistance to scaling and oxidation under conditions which occur in service.

STEELS FOR HIGH TEMPERATURE SERVICE.


Scope of the Research ;
Steels for use in plant operating within range of temperature (350 deg.–600 deg. Cent.)
Carbon and low-alloy steels (wrought and cast)
Study of the effect of composition and variations of heat treatment
Requirements ;
Resistance to stress over long periods of time
Resistance to oxidation and scaling
Creep tests
Corrosion tests in special apparatus
Methods of Investigation ;
Determination of rates of creep
The effect of exposure of materials in high temperature creep tests (spheroidisation, intercrystalline attack, &c.)
Determination of rate of corrosion in high pressure steam, 1000 lb. per square inch, 600 deg. Cent.
Determination of rate of corrosion in high temperature flue gases, 600 deg. Cent.
Results of Research ;
Fundamental data for design
Comparative data for selection of steels for service

In order to obtain critical data for a basis of comparison with alloy steels an investigation of the behaviour of a series of carbon steels (0·15 per cent., 0·4 per cent., and 0·6 per cent. C.) has been undertaken. The unusual behaviour of at least one of these steels at 450 deg. Cent. necessitated the study of a large number of carbon steels, and a consideration of the effect of structural conditions in those steels. It has been found that rolled carbon steels of approximately the same composition and heat treatment may vary considerably in their resistance to creep at 450 deg. Cent., and that the resistance to creep of carbon steels does not necessarily increase with increase in carbon content from 0·15 to 0·4 per cent. Attention is being given to an examination of the extent to which variations in the conditions of manufacture of carbon steels affect their resistance to creep.

Important investigations are being carried out into the properties of low alloy steels, notably plain molybdenum steels and complex molybdenum steels. The results of the initial work on commercially produced steels containing 0·15 per cent. C and 0·4 per cent. C with additions of 0·5 per cent. Mo and 1·0 per cent. Mo showed the extent to which the presence of molybdenum improved the creep resisting properties of a steel.

Considerable progress has been made in exploring the influence of thermal treatment upon these important steels, and the work demonstrated that if their high resistance to deformation at elevated temperatures is to be utilised, their thermal treatment is of great importance. The heat treatments have been applied to the steel after a consideration of the data derived from the study of transformation temperatures and microstructures. It has been shown, however, that these plain molybdenum steels failed with comparatively low elongation owing to intercrystalline cracking, when subjected to fairly high prolonged stresses at 550 deg. Cent. Various heat treatments were applied to these steels, but the results of tests have not so far indicated that intercrystalline cracking can be entirely eliminated by adopting a particular heat treatment. Tests are in hand to determine whether intercrystalline fracture is likely to be associated with the very small rates of creep permissible in steam turbine plant. It has been shown that the impact resistance of the low-carbon molybdenum steels has not been impaired by prolonged heating at 450 deg. Cent. and 550 deg. Cent.

Steps are now being taken to discover what element or elements, added in small percentages to molybdenum steels, will eliminate intercrystalline cracking at 550 deg. Cent., without appreciably diminishing the very favourable creep-resisting properties resulting from the presence of molybdenum.

In the meantime it has been established that the addition of copper up to 0·5 per cent. to carbon steel provides no improvement in regard to resistance to creep at 450 deg. Cent., but in the presence of other elements copper may have a beneficial effect.

The study of the creep properties of the steels enables data to be accumulated for the design of plant, but considerations of certain service conditions indicate that the steels must also withstand oxidation and attack by superheated steam and flue gases. The resistance to attack is a problem which is capable of being solved by experimental means and suitable apparatus for the study of this problem has been put into operation. The attack of superheated steam is being investigated in a high-pressure reaction vessel capable of maintaining specimens of the steels at 600 deg. Cent. under a pressure of 1000 lb. per square inch. The study of the attack of flue gases has been investigated on various steels in flue gas mixtures containing sulphur dioxide. Two methods have been put into use; the first consists of an examination of wires, the decay being noted by decreases in the electrical conductivity and tensile strength, and in the second method the nature of the attack on massive specimens has been studied in view of the protective action of initial oxide layers.

The scope of the research will be clear from the annexed diagram. One of its main objects is the determination of conditions of material and treatment which will make it possible to increase operating temperatures by one or two hundred degrees Fahrenheit.

The investigations have now reached a stage at which tangible results are being obtained. The subject is of importance to the engineering industry on account of the steady increase in operating temperatures and pressures which characterises modern practice, whilst, although the quantity of steel concerned is not large in comparison with the total output, the fact that a user may have to go abroad for the latest developments in materials is a fact of great importance to the steel industry, which urgently needs the fullest information as to the properties required in these special qualities of material. The British steel industry owes its foremost position to its pioneer character and technical superiority, and it is important that it should maintain that position in such special departments as that of materials for high temperatures.

It may be emphasised that very close contact is maintained between the work of the Committee and that of the D.S.I.R. High Tension Committee. The latter Committee is concerned not only with the investigation of the properties of existing commercial materials at high temperatures, but with the exploration of the fundamental aspects of the subject. Reports on this work have been, and are being, published. These reports have obtained a wide circulation among engineers and others vitally concerned with the properties of metals at elevated temperatures. On account of the authoritative character of the data presented they have formed the basis of design of such parts as steam generators and superheaters, steam piping and fitting, and important steel forgings and castings required for service in steam power plant, and other equipment operating at temperatures at which the phenomenon of creep becomes of prime importance. In providing a basis for the rational design of parts in carbon steels for employment at elevated temperatures, these reports have contributed in no small measure to the important position occupied by British engineers and steel manufacturers in the construction of steam power and other plant operating at elevated temperatures.

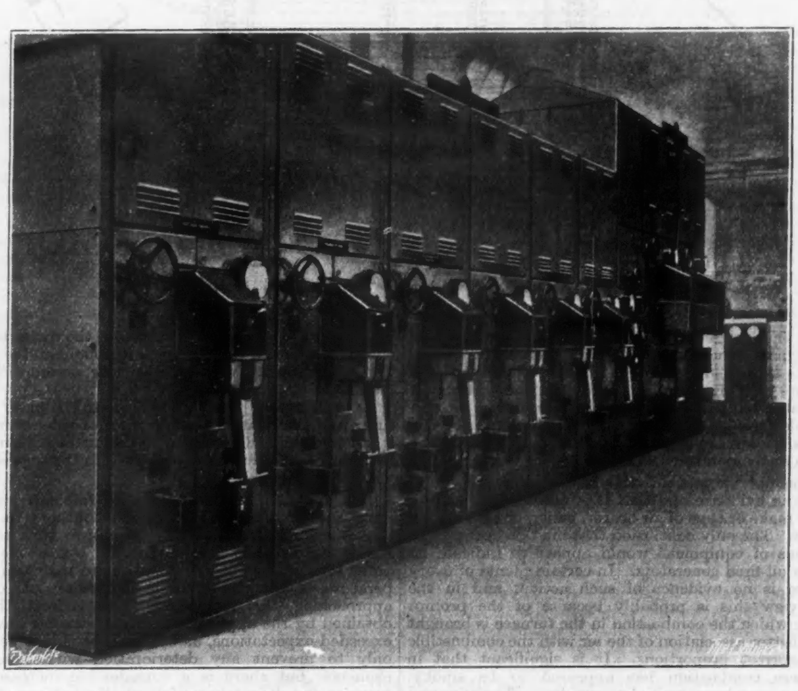
Heavy Current Switchgear.

A LOW-VOLTAGE, heavy current switchgear installation possessing special features has been carried out by Ferguson, Pailin, Ltd., to the order of the Central Electricity Board. It controls the output of two 4000-kVA transformers, which provide the supply from the "grid" to J. and P. Coats, Anchor Mills, Paisley, and although the equipment is of a somewhat unusual character, the contract was completed within eight weeks. Another contract has since been placed with the same firm by the Central Electricity Board for a similar low-tension installation for controlling three 6000-ampère incoming supplies from the "grid" to a second mill belonging to J. and P. Coats, Ltd. In this case the original generating plant is being retained, and it is to be operated by the Central Electricity Board as a selected station.

The new switchgear that is now in operation is shown in the first of the accompanying illustrations, from which it will be seen that it is of the cubicle type. There are two incoming 5000-ampère panels and six hand-operated, 2000-ampère panels, controlling outgoing feeders to the factory. The three-phase rupturing capacity is 80,000 kVA with a corresponding "making" current or an initial value of fully asymmetrical short-circuit current of approximately 300,000 ampères. The electro-magnetic effects of this current naturally give rise to considerable forces, the repulsive force on the terminals of the round circuit breakers installed in the incoming feeder cubicles being in the neighbourhood of 13,000 lb. The short-circuit current also applies a downward "throw-off" force to the moving contact bars of approximately 6000 lb.

The operating mechanism and electrical conductors of the breaker, which is shown in the second illustration, are designed to have an adequate factor of safety under short-circuit conditions, while the solenoid closing mechanism develops sufficient power to make a contact of adequate area and to compress the "kick-off" springs sufficiently before the closing movement is reversed by mechanical tripping of the breaker, thus preventing the possibility of the contacts welding in.

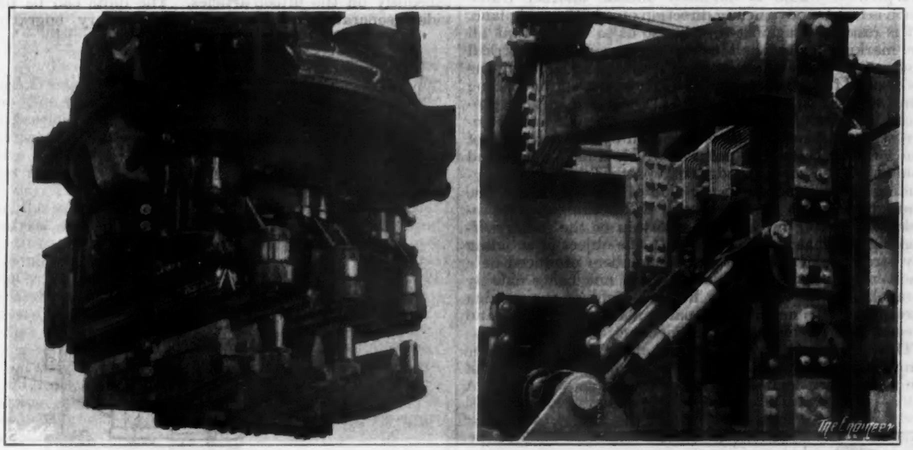
The full floating self-aligning main contact fingers and the V-shaped moving contact bars are silver-plated, which obviates the necessity for frequent cleaning without lowering the surface conductivity. The arcing contacts of the rose and candlestick type are capable of dealing with the maximum current which can occur when the breaker is closed on a short circuit. In the outgoing feeder cubicles the 2000-ampère breakers are similar to those described.



80,000 - kVA, 525 - VOLT CUBICLE SWITCHBOARD

All the breakers are enclosed in round steel welded tanks, which are almost entirely fabricated. A special truck equipped with tank raising and lowering mechanism serves for removing the breakers.

The cubicles contain 5000-ampère bus-bars and connections of the same capacity are provided in the incoming cubicles. Provision is made in the heavy current cubicles and bus-bar chambers to prevent overheating and mechanical ailure due to the normal and short-circuit current, which, with an initial asymmetrical value of 300,000 ampères, results in a repulsive force of over 2000 lb. per foot run. Ventilators are provided at the top of the cubicles and ventilating louvres on the front and rear doors. All inner horizontal screens are composed of perforated aluminium, which, while permitting free natural ventilation, also minimises local heating due to eddy currents. Portions of the cubicle structure in proximity to heavy current conductors are constructed on non-magnetic steel angles and complete magnetic circuits around conductors are thus avoided.



5000 Ampere Breaker Contacts and Main Connections

Current transformers for metering and for the protective gear are provided in the 5000-ampère incoming panels, and special precautions are taken to minimise the effects of interaction between transformers. All the main conductors which are braced by bronze clamps to withstand the forces developed by short-circuit currents, work at a maximum current density of 500 ampères per square inch. The bracing mentioned is supplementary on the bus-bars to the insulated bus-bar supports.

The lay-out of all the apparatus has been designed with a view to convenient operation with a simple run of main conductors. The bus-bar isolating switches to be seen in the third illustration are gauged and operated by an external hand wheel through a chain drive and worm reduction gearing, the usual indication and padlock arrangements being provided. A separate chamber accommodates the potential transformer, whilst its fuses on the primary side are mounted behind a separate hinged panel, which enables the fuses to be removed and replaced safely without interfering with the main equipment.

Bare copper conductors run at a maximum current density of 500 ampères per square inch, form the main connections between the power transformer control panels and the transformers themselves. They are carried on insulated blocks from a steel supporting structure and are enclosed by expanded metal screens. Bronze clamps serve to brace these connections in a similar manner to the switchgear bus-bars in order that they may withstand the short-circuit forces. With the phase spacing adopted for the connections, the maximum force is in the neighbourhood of 2500 lb. per foot run, and in designing the bracing clamps an ample factor of safety was allowed.

The consulting engineers for the work were Messrs. Kennedy and Donkin.

Telephone Interference.

Recent investigations on telephone interference are described in a paper by Messrs. W. G. Radley and S. Whitehead, presented at a meeting of the Institution of Electrical Engineers on Thursday, November 23rd. The subject is roughly divided under two heads—disturbance from harmonics during normal operation of the power system, and danger due to excessive induction at the fundamental frequency under transitory fault conditions. The former gives rise to noise and with regard to its disturbing effect may be calculated or measured in terms of E.M.F. at 800 cycles per second. In the same way the total harmonic output of electrical plant may be expressed by its telephone interference factor. For modern installations this quantity can usually be kept below 1 per cent.

Although mercury arc rectifiers exceed this value, the telephone interference factor can be reduced to less than 1 per cent. by appropriate smoothing equipment. Both disturbance and danger are generally due to induction from earth currents. The magnitude of the current is investigated for various cases, and it is shown that the earth current can be calculated if the earth resistivity is known. Alternative methods of measuring this are available. The screening effect of conductors in parallel (such as telephone or power cable sheaths, earth wires, and rails) must be taken into account, and formulæ and experimental measurements are given for these.

Indications are given in this paper as to how various types of interference may be decreased, as by the suitable choice of generators and transformers, neutral impedances and filters, output filters, additional earth wires, the use of power cables or telephone cables instead of overhead circuits, the design of cable sheaths, balancing of communication circuits, the choice of earthing methods, &c. The decision as to the appropriate method rests upon many considerations of cost, practicability, and convenience, and must be determined by agreement for specific cases. Information is given as to how the interference may be predetermined for given systems so that the merits of the various possible alternatives can be quantitatively compared, while, at the same time, the possibility of interference in connection with a projected system can be found beforehand.

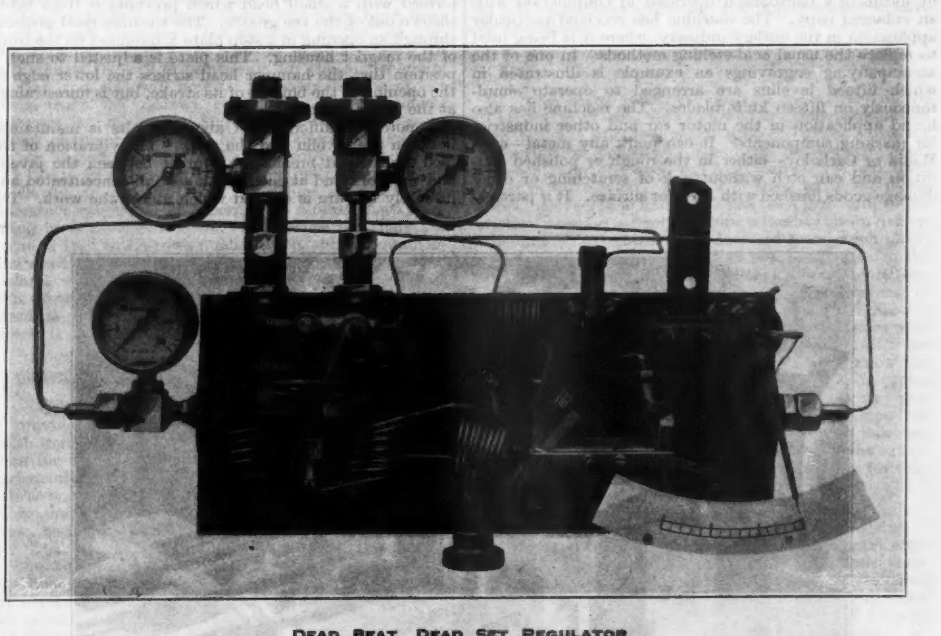
Although further study of certain aspects of the subject is still needed, it is concluded that theory and experience are available for the approximate calculation and predetermination of the amount of interference likely to occur in any given case.

A Dead Beat, Dead Set Regulator.

A new form of regulator for such purposes as controlling the flow through a reducing valve to maintain a constant temperature has recently been devised by the Drayton Regulator and Instrument Company, Limited, of West Drayton, Middlesex, and is illustrated by the accompanying engraving, while its action is indicated in the diagram.

The purpose of this instrument is not merely quickly and positively to adjust the valve with changes of load, but also to assure that the temperature maintained shall be the same at full load, no load, and all intervening stages.

Referring to the diagram, it will be seen that the reducing valve A is actuated by a diaphragm. This diaphragm is subject to an air pressure provided at B at a constant pressure of about 15 lb. per square inch. The air is admitted to a small chamber and passes through a calibrated orifice on its way to A. Beyond this orifice there is a leak away opening C, controlled by the aneroid capsule D. This capsule is in communication with the main air supply, and also with another leak opening E. The extent of this opening E is governed by a radially moving flap F. The movement of this flap is brought about by the attached bell crank F_1 and the thermostat G.



Dead Beat, Dead Set Regulator

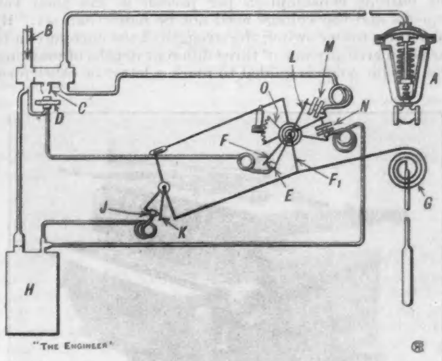
With this arrangement a drop in temperature at the thermostat will cause its coil to wind anti-clockwise, open the gap between F and E, and thus reduce the pressure in the capsule D. This will open the leak away C and reduce the pressure on the diaphragm of the valve A, which will open to pass more steam. The valve takes up its new position almost instantaneously, but at the same time another action takes place.

The orifice E is mounted on an arm that pivots with the arm L which is anchored by the aneroid capsule M. This capsule is in communication with the air pressure for operating the diaphragm of the valve A. The result is that there is a follow-up action between the orifice E and the flap F, which reduces hunting of the valve.

Without other arrangements, however, it is probable that the new position of the valve would be such that the temperature maintained would be slightly above or below the standard required.

In order to meet these conditions there is a further control of the setting, which embodies a time-lag device in the form of an air receiver H. This receiver is supplied with air under pressure through an orifice, and has a leak-away J and flap K. This flap is interconnected with the thermostat G.

The air receiver H is connected with the capsule N, which can move the anchorage of the capsule M. The result is that while a reduction of temperature at G tends to increase the opening E F, and by reducing the air pressure open the valve A, the decrease in pressure in M tends to reclose the opening E F. At the same time the thermostat has closed the opening J K, so that the pressure in H and N is increased and there is a tendency for M and L to move forward and increase the opening E F to reset the valve A. The merit of having a receiver of appreciable capacity at H lies in the fact that it gives opportunity for the conditions to adjust themselves before the resetting takes place. The worm and wheel O provide a means of adjusting the relative positions of the nozzles E and J, and thus setting the instrument.



Action of Regulator

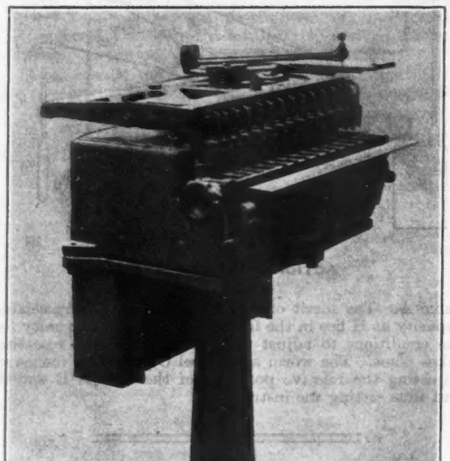
THE MOTOR TRAWLER ALA.

The new motor trawler "Ala," which has recently been constructed at the yard of Richards Ironworks, Ltd., of Lowestoft, for the service of the East Anglian Ice and Cold Storage Company, Ltd., marks a further advance in the use of the oil engine in fishing craft. This new trawler, which has now undergone her official trials, will be the forerunner of a fleet of twelve motor trawlers. She has been designed by Mr. S. G. Richards, and was built under the supervision of Mr. B. S. Tharp, A.M.I. Mech. E., of Hamilton Dock, Lowestoft, the consulting engineer for the owners. She has a length of 75ft., a beam of 20ft. 6in., with an amidship depth of 9ft. 6in., and an after draught of 10ft. Good accommodation is provided for a crew of six men, with a separate cabin for the skipper.

The main propelling motor, which is also arranged to drive the trawl winch by belt, consists of a five-cylinder Ruston and Lister oil engine, designed to develop 150 B.H.P. at 235 r.p.m., the cylinder dimensions being 11in. bore and 14½in. stroke. A simple system of controls has been arranged with compressed air starting, and engine-driven pumps and a 1½ kW, 110-volt generator driven from the main shaft of the engine. The trawl winch was supplied by J. S. Doig and Sons, Ltd., of Grimsby, and it carries 300 fathoms of 2¼in. circumference warp on each drum, two whipping drums being arranged on the high-speed shaft. When the winch is not required, the driving belt is left slack, but the drive is put into operation by means of a jockey pulley operated by the winch man from the deck. An auxiliary unit consists of a 7 B.H.P. single-cylinder Ruston-Lister engine driving a 1½ kW, 110-volt generator, a single-stage air compressor, and a general service pump. The machinery was installed by the Ruston Lister Marine Company, Ltd. The trials of the trawler were, we learn, successful, a speed of about 8½ knots being attained.

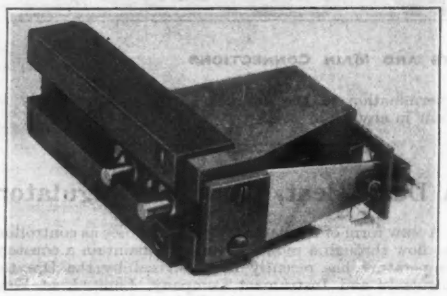
An Electric Etching Machine.

To the considerable range of engraving machines operating with a pointed cutting tool made by Taylor, Taylor and Hobson, Ltd., of Leicester, Mr. Wm. Taylor has now added an engraving or etching machine, in which the pointed cutting tool is replaced by an electric "javelin" from which a rapid succession of sparks passes to the work and so marks it. The javelin is composed of a tungsten alloy and is supplied with alternating current. The current consumption per javelin is less than two ampères and the voltage need not be more than six. By means of a rotary switch the strength of the current can be varied to give any one of three different depths of marking. The javelin point is guided to mark a letter or other form by means of a pantograph operated in conjunction with an enlarged copy. The machine has received particular application in the cutlery industry, where it is being used to replace the usual acid-etching methods. In one of the accompanying engravings an example is illustrated in which fifteen javelins are arranged to operate simultaneously on fifteen knife blades. The machine has also found application in the motor car and other industries for marking components. It can mark any metal—even Widia or Carboloy—either in the rough or polished condition and can etch without risk of scratching or other damage goods finished with a mirror surface. It is particularly suited to operation by unskilled labour. Its total consumption of power is low—the fifteen-unit knife etching machine taking not more than 300 watts—and the current and voltage being of the same order as in a domestic electric bell, there is no danger of the operator's receiving a shock. The javelin points are readily replaced when they become worn and do not need to be re-sharpened during their life.



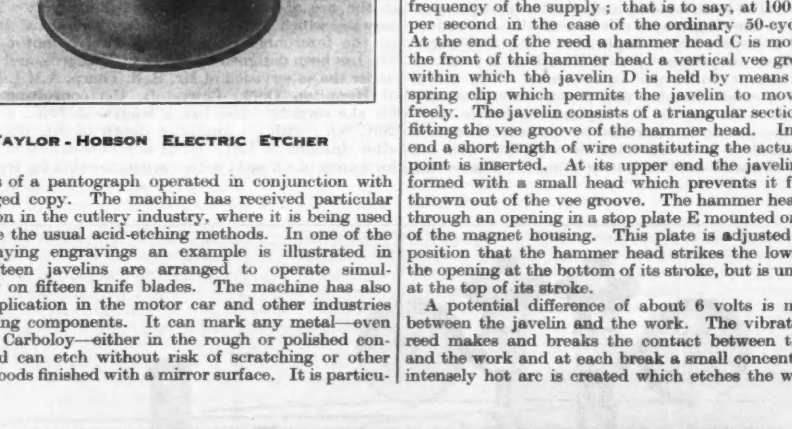
Taylor-Hobson Electric Etcher

The marking units in the knife-etching machine illustrated are bolted to a tee slot running along the front face of a frame mounted on a pair of horizontal pivots. By means of a cam lever this frame can be raised and lowered round these pivots to facilitate the changing of the work. This pivoted frame is mounted outside another frame which is free to move in any direction on a horizontal plane, but is restrained against rotation so as to ensure that all the marking units shall execute the same geometrical movement. The support and constraint of the inner frame are derived from balls rolling in vee grooves, spring loading being applied to eliminate any play that might be produced by wear. The motion of the inner frame and therefore of the marking points is governed by a pantograph of 7 to 1 ratio, the tracing point of which is moved by hand round the raised or sunk edges of a pattern fixed to a copy-holding table attached to the side of the machine. The pantograph joints are fitted with ball bearings with provision for taking up wear. In certain of the joints self-aligning bearings are provided with the object of avoiding any straining of the pantograph members produced as a result of the fixed and moving axes not being exactly parallel. Despite the fairly heavy weight of the moving parts, these arrangements impart great sensitiveness and sweetness of movement to the machine.



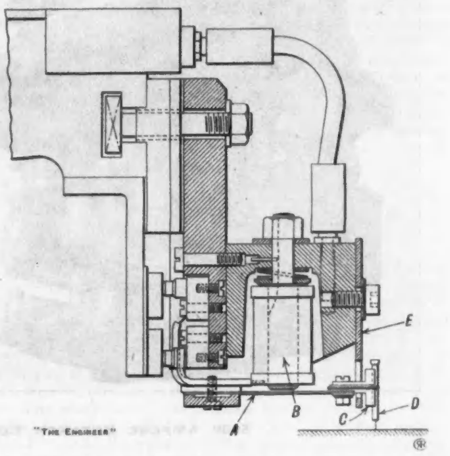
An Etching Unit

The marking units can be spaced along the tee slot in the frame supporting them at intervals to suit the width of the work being dealt with. Each is complete in itself. A stiff steel reed A is mounted beneath an alternating current magnet B and is tuned to vibrate at twice the frequency of the supply; that is to say, at 100 vibrations per second in the case of the ordinary 50-cycle supply. At the end of the reed a hammer head C is mounted. In the front of this hammer head a vertical vee groove is cut within which the javelin D is held by means of a light spring clip which permits the javelin to move endwise freely. The javelin consists of a triangular sectioned shank fitting the vee groove of the hammer head. In the lower end a short length of wire constituting the actual working point is inserted. At its upper end the javelin shank is formed with a small head which prevents it from being thrown out of the vee groove. The hammer head projects through an opening in a stop plate E mounted on the front of the magnet housing. This plate is adjusted to such a position that the hammer head strikes the lower edge of the opening at the bottom of its stroke, but is unrestrained at the top of its stroke.



Etching a Batch of Table Knives

A potential difference of about 6 volts is maintained between the javelin and the work. The vibration of the reed makes and breaks the contact between the javelin and the work and at each break a small concentrated and intensely hot arc is created which etches the work. The arrangement is self-feeding. When the hammer head strikes the lower edge of the aperture through which it projects the sudden check to its motion causes the lightly held javelin to shoot downwards in its groove until its point makes contact with the work surface. In this way compensation is provided for the burning away of the javelin point, which occurs in course of time. In addition, this automatic adjustment of the javelin point enables etching to be done as readily on a curved as on a flat surface. The depth of the etch is, as previously stated, controlled by the voltage applied. The width of the etched lines is governed by the diameter of the javelin point. As the point burns away its diameter remains constant and therefore no change occurs in the width of the etched lines. The life of the javelin depends upon the depth of the marking. On such work as stainless cutlery with inscriptions of a usual character about twenty gross of knives, we are informed, can be marked with one set of fifteen javelins. The total power consumption of the knife-etching machine is about 300 watts. Its output is at the rate of from ten to twelve letters per minute marked simultaneously on the fifteen articles. The units can be provided separately for use in any ordinary engraving machine in place of the cutting tool. In one form the unit is supplied as a hand instrument, whereby freehand etching without a copy can be performed.



Details of Etching Unit

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. L. I. C. Schwaiger, who was associated with the export department of Blackstone and Co., Ltd., has now joined Davey, Paxman and Co. (Colchester), Ltd., as manager of the overseas department.

Marshall, Sons and Co., Ltd., Gainsborough, inform us that they have recently appointed Harry Astbury, Ltd., of 63, Hockley Hill, Birmingham, as their representatives in the Birmingham district.

Hick, Hargreaves and Co., Ltd., Soho Ironworks, Bolton, have sent us a copy of an attractive brochure which they have issued in connection with their centenary, which was referred to at some length in our issue of November 10th, 1933.

We understand that the business of Sir John H. Biles and Co., naval architects, is being carried on by the late Sir John Biles' former colleagues, without alteration of name, and that the firm has received re-appointment as naval architects to the Government of India.

The Associated Equipment Company, Ltd., has appointed Mr. C. W. Reeve, the present managing director of the company, to be chairman of the board, and also to continue in the office of managing director. Lieut.-Col. J. T. C. Moore-Brabazon, M.C., at the same meeting, was elected to be deputy chairman.

Cox and Danks, Ltd., Stevenson-road, Sheffield, 9, request us to say that their activities on the North-East Coast as iron and steel merchants will be conducted through a new branch office, which will be opened at Prudential Buildings, Mosley-street, Newcastle-on-Tyne (telephone number 27900), on December 4th, with Mr. J. Farrer as manager.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

Stewarts and Lloyds, Ltd., have received from the Crown Agents for the Colonies a contract to supply the steel portion of the pipe line required for supplying water to Jerusalem. The order consists of about 31 miles of 18in. steel pipes, which are to be used for pumping water from the springs at Ras-el-Ain. There will be four pumping stations with a reservoir at each. The mains will follow the railway to Lludd and thence the road from Jaffa to Jerusalem. The scheme is to be proceeded with immediately and it is understood that the construction is in the hands of the Public Works Department under the direction of Mr. Fawcett Pudsey, Director of Public Works, Palestine.

LAUNCHES AND TRIAL TRIPS.

Great Western, twin-screw steamer; built by Cammell Laird and Co., Ltd., to the order of Great Western Railway Company, for Fishguard-Wexford service; dimensions, 280ft. by 40ft. 3in. by 17ft. 1in.; to carry passengers and cattle. Engines, triple-expansion; constructed by the builders; launch, November 21st.

Inchangu, motor vessel; built by Workman, Clark (1928), Ltd., to the order of Messrs. Andrew Weir and Co., London; dimensions, 425ft. by 57ft. by 37ft.; to carry passengers and cargo. Oil engines, Workman Clark-Sulzer type; constructed by the builders; launch, November 21st.

Engineers' German Circle.—On the evening of Monday, November 27th, members, friends of the Circle and their ladies met at the Holborn Restaurant for a dinner and dance. Over forty members and guests were present, and the chair was taken by Dr. S. J. Davies. Herr E. H. Rüter, of the German Embassy, proposed the toast of "The Ladies," and paid a tribute to the good work the Circle is doing in bringing together the engineers of the two countries on the basis of their work. A very enjoyable evening was spent, and thanks are due to Mr. H. P. Spratt, the secretary, for the excellent arrangements made. Any inquiries as to the membership and activities of the Circle should be addressed to Mr. Spratt at the Science Museum, London, S.W.7.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Forthcoming B.S.I. Specifications.

Two interesting specifications are likely to be issued shortly by the British Standards Institution. For some time the Institution has been dealing with the new specification for high-tensile steel, and this has now been practically approved and will be published probably before Christmas. It is understood that the new tensile stress will be 37/43 tons and that the yield point will be 23 tons. The interest attaching to this specification arises from the growing demand for this class of steel. Other countries are taking up its manufacture in increasing quantities. The German steel makers in particular are developing this side of their business, and it is stated that recently 50 per cent. of their steel exports have been of special steel. In France, too, there is a tendency to concentrate upon the output of high-tensile material. Another specification which is awaited with interest relates to wrought iron bars. Specification 51 has been revised and in the course of revision further special grades of puddled iron bars which are used in the manufacture of chains and lifting material have been included,. It is probable that this specification will be circulated for comment shortly.

Pig Iron.

The chief characteristic of this market is the willingness of consumers and dealers to place forward contracts, and the caution with which many of the producers negotiate this class of business. The position varies in different parts of the country, but, excepting perhaps in Scotland, there is a similarity in the general features of the market, which all tend towards firmer conditions. The position of foundry iron on the North-East Coast is causing some anxiety to users, and this is indicated by the pressure which is exercised upon makers to enter into long-date delivery arrangements. In some cases business has been done for delivery as far forward as the end of June next year. There seems no doubt that the whole of the foundry iron produced on the North-East Coast is going into consumption, the greater part of it being taken up by local and Scottish consumers. In the latter market Northamptonshire brands are being offered at 64s. d/d Glasgow and 61s. d/d Falkirk, against the 65s. 3d. and 62s. 3d. quoted by the Cleveland makers, but most of the light casting foundries are so accustomed to Cleveland iron that they take larger quantities of that description than of Northants. Stocks in the Midland makers' hands still amount to a substantial tonnage; but taking into account the iron sold for forward delivery plus the quantities disposed of in day-to-day sales, heavy inroads have been made in these accumulations. In this district, however, consumers appear to entertain little fear of a shortage arising for some time, and some are content to keep themselves covered only a short distance ahead. In Lancashire buying has been more satisfactory than for some time, consumers in this district apparently being somewhat apprehensive of an advance in prices. It is not easy to judge the position in the basic iron market, as so much of the business transacted in this description does not come on the open market, owing to the steel works taking it from associated concerns. So far as can be judged, little business has been done since prices were increased, a number of large contracts having been entered into immediately before the advance. There is also a steady sale of Indian basic, which is imported by arrangement with the Indian producers at the rate of 60,000 tons per annum. It is said that the British makers would like this quantity reduced, but the arrangement is not likely to be varied for some time. Business in hematite iron is satisfactory, and some makers have declined to sell far forward at current rates.

The N.E. Coast and the Midlands.

There is no sign so far of the falling off in business which usually occurs a few weeks before Christmas in the finished steel department of the market. The demand for nearly all classes of these products is growing, but the outstanding feature of the position is the heavy pressure on the part of merchants and consumers to secure supplies of small steel bars. The steel works and the re-rollers alike are full up with orders, and in many cases are behindhand in deliveries. On the North-East Coast business has expanded so much that it is expected the two steel furnaces which have been relighted will have to be increased to four. The constructional steel shops in this district are better employed than in other parts of the country, but would welcome new business. The rail mills are also busy on recent orders. The active conditions which have ruled in the Midlands for some time show no sign of relaxing. The demand for structural steel arising from the engineering industries has improved, but the number of large engineering orders coming to this district is limited by the competition experienced from outside, particularly from the North-East Coast. The lighter branches of the trade, however, are probably busier in the Black Country than elsewhere. Continental competition is strong in small bars, strip, joists and structural steel generally, but in spite of the comparatively low prices accepted by foreign sellers, the bulk of the business passing is going to British works. The situation as regards strip is particularly satisfactory, and many of the makers are rationing their customers and in some cases are behindhand in deliveries. For small bars the re-rollers quote £7 5s., whilst the steel works ask £7 10s. to £8 10s., according to quality. The Continental steel works organisations are willing sellers at £6 10s. to £6 10s. 6d. d/d, including duty. Stockholders, however, do not seem to be placing much business with Continental works, perhaps because there is a marked tendency on the part of users to require British material. Another department of the industry which has shared in the recent improvement in business is that providing colliery material. The demand, however, is restricted to small tonnages, and buyers are limiting their requirements as much as possible.

Scotland, Lancashire, and the North.

The better outlook in the shipbuilding industry has created a cheerful feeling in the Scottish steel industry. The total tonnage of steel which will be required to complete the orders may be only moderate, judging from the quantity which finds an outlet in the shipyards in normal times, but the new orders are believed to be only the beginning of renewed activity on the Clyde. For longer than most of the steelmakers care to remember, the poor demand for the descriptions of steel used in shipbuilding has been reflected in idle plant at the steel works, and the prospect of an improvement in this direction has improved the tone of the market. The announcement that a share of the order for a hundred locomotive engines for the L.M.S. Railway will be allocated to a Glasgow firm is welcome news for the plate mills, since business in boiler plates in particular has been at a low ebb for some time. The reverse side of the picture, however, is presented by the re-rollers, who are sharing in the trade improvement to only a moderate extent. Short time working is general in this department, and little improvement is to be seen in either the home or export demand. There has been an active request for sheets of late, and this section of the industry is assured of busy conditions until the end of the year. In Lancashire the orders for locomotives already referred to will provide a stimulus to the plate industry for which it has been waiting for some time. Officially, the quotation for boiler plates is £8 5s., but lately makers have not rigidly adhered to this limit when a good order was in prospect, but these have been few and far between. The quantities of steel required by the constructional engineering establishments is showing some improvement, but is still well below the capacity of the steel works. There is a strong demand for bright drawn steel and for black steel bars, and the re-rollers are so busy on the production of small steel bars that they are cautious in committing themselves to forward contracts. Continental merchant bars and structural material have been freely quoted in this market, but the business passing with either merchants or consumers has been confined to small quantities. No special feature has developed in the Sheffield market, but the rate of operations at the steel works has been maintained.

Finished Iron.

Business in the finished iron department continues to hang fire, although the orders for railway wagons and locomotives will bring a welcome increase in work, particularly to those firms supplying the better-class descriptions. Recently, also, some orders from the Indian railways have reached the industry, but these have been for only small tonnages. The situation at the bar iron mills seems to be much the same in most districts. In the Midlands the call is principally for the higher grade material, and this will now be increased by the orders arising from the railway contracts. The commoner grades are less in demand and continue to feel the competition of the cheaper steel bars. Staffordshire marked bars are quoted at £12 at works; Crown bars are quoted at £8 10s. to £9 10s., and the common quality ranges from £6 17s. 6d. to £7 10s. The Lancashire mills are only moderately employed, but there is no indication of price cutting on a noticeable scale. Lancashire best bars are firm at £9 10s., with Crown quality at £9, cheaper qualities being quoted down to £7. Similar conditions prevail in Scotland, where the plant at most works is occupied only about three days a week. Scottish Crown bar iron is offered at £9 15s., d/d railway sidings, whilst export business is conducted on the basis of £9 5s. f.o.b.

Current Business.

The 1934 programmes of the railway companies are providing a considerable volume of work for the British iron and steel makers. The L.M.S. has given out orders for 100 railway locomotives, this contract being supplementary to that for 2000 wagons recently placed. Of these engines, fifty will be built by the Vulcan Foundry and Engineering Company, Ltd., of Newton-le-Willows, Lancs., and fifty by the North British Locomotive Company, Ltd., of Springburn, Glasgow. Several new orders for ships have been placed, including one for a 10,000-ton cargo boat with Wm. Hamilton and Co. (1928), Ltd., of Port Glasgow, whilst Harland and Wolff, Ltd., of Govan, have taken a contract for a refrigerated cargo motor ship of 12,000 tons d.w. and a 12,000 tons d.w. oil tanker. A contract which will provide welcome employment for the tube works has been secured by Stewarts and Lloyds, Ltd., for the supply of the pipe line for the Jerusalem water supply scheme. This line will consist of about 31 miles of 18in. steel pipe. There will be four pumping stations with a reservoir at each station, and the orders for the pumping machinery will also be placed with British works. The Trinidad water supply scheme, which has been held up for a time, is likely to be proceeded with, and this may provide work for the British tube makers. This scheme may be spread over a number of years. It is also announced that the old Brymbo Steel Works, near Wrexham, are to be reopened after being closed down for three years. The Crown Agents for the Colonies have awarded the Motherwell Bridge and Engineering Company, Ltd., Lanarkshire, the contract for a road and rail bridge in Jamaica, and for a road bridge in Kenya. The same firm has taken a contract for the erection of a road bridge in Natal. Ashmore, Benson, Pease and Co., Ltd., of Parkfield Works, Stockton-on-Tees, have secured an order for the construction of a blast-furnace at the Cardiff Steel Works of the British (Guest, Keen and Baldwins) Iron and Steel Company, Ltd. The furnace will be capable of a weekly output of 4000 tons of pig iron, and will probably be completed by about the middle of next year. Balance sheets of some of the electrical engineering concerns point to sound conditions in that industry. Crompton Parkinson, Ltd., show a profit of £102,187 for the year ending September 30th, 1933, and the following dividends are recommended:—4 per cent. on the 8 per cent. first preference shares, and 3 per cent. on the 6 per cent. second preference shares in respect of the six months ended September 30th, 1933; 6½ per cent. actual on the ordinary and "A" ordinary shares, making, with the interim dividend paid in June, 12½ per cent. for the year. The British Electric Transformer Company, Ltd., shows a profit of £18,463, against a loss last year of £10,265. A dividend of 5 per cent. on the preference shares for the nine months ending September 30th, 1933, is recommended.

Copper.

Rather steadier conditions have ruled in the electrolytic copper market this week, although buying has been on anything but an important scale. The copper producers have taken advantage of the firmer tone of the dollar to raise their prices slightly, and their export quotation, after being unaltered for some days at £33 10s., advanced to £33 15s. The worst feature of the market is that consumers have not shown much interest in the metal. In America conversations are being continued regarding the copper "code," and it is expected that it will soon be put into operation. The general view is that it will provide for a domestic consumption in the United States of about 20,000 tons to 22,000 tons per month. Possibly, this will about meet the demands of the market, but it is far below the normal consumption, which even before the war was about 30,000 tons per month. The producers point to the steady reduction in the stocks which has taken place during the last few months. At the end of October the stocks in North and South America were given as 520,500 tons, whilst the production was only 33,500 tons. Some doubt, however, is felt regarding these figures, as it is suggested that earlier in the year large copper-using concerns which are associated with producing interests took important quantities of the metal in order to relieve the latter from some of the burden of carrying the metal. It is assumed that all this copper has not been used, and that in considering the copper position in America allowance must be made for these hidden stocks. The London standard market, after showing a certain amount of weakness, became suddenly active at the beginning of this week on a considerable volume of speculative buying and bear covering. Prices advanced rather sharply, but there seemed little confidence in the market, and it would not be surprising if a reaction took place. Buying for investment purposes in this market seems to have ceased for the time being, and, in fact, a fair proportion of the purchases made early in the year appear to have been liquidated.

Tin.

An easier tone developed in the market at the end of last week, and was followed by some liquidation which brought about a sharp drop in prices. Buying by Continental consumers has been particularly poor, and excepting at the week-end American buyers took little interest in the market. In spite of these adverse circumstances, however, the undertone has been firm, and as the statistical position is likely to show a further improvement at the end of November there does not seem much likelihood of an important decline in values. Deliveries in the United States are not expected to reach a large figure, but on the other hand, there have been heavy shipments of tin to Russia this month, which have helped to swell deliveries to the Continent. Some of the recent sales were ascribed to operations by interests associated with the Pool, and the market would very much like to know the extent of the holdings of that body. Business in tin-plates has declined somewhat of late, both in this country and in America, and this, of course, may reflect upon the demand for tin. The worst feature of the market has been the indifference shown by consumers and to a great extent the fluctuations of the dollar exchange are blamed for this.

Lead and Spelter.

A steady tone has ruled in the lead market after prices had shown a weaker tendency. Of late there has been a considerable amount of liquidation of stale bull accounts, but in some cases the market is inclined to think that metal which was bought some time ago as a hedge against currency depreciation has been disposed of. Recently the Soviet Government bought important quantities and most of the Mexican lead which was declared on market early in November has thus been disposed of. The industrial demand has been fair, but most of the large consumers appear to be well covered. The favourable weather, by enabling building operations to be continued late into the season, has helped to maintain the demand for manufactured products, and this is reflected in a sustained if small demand for pig lead. . . . The position in the spelter market has not materially altered, prices have been firm, although there has been a certain amount of liquidation of speculative accounts. The statistics issued by the Continental Cartel showed an increase in the stocks of about 1500 tons, whilst the October production is given as 57,877 tons. The demand from consumers has been upon a disappointing scale, the requirements of the galvanisers in particular being less than normal at this season. On the Continent, however, it is reported that industrial requirements, after declining for some time, have again increased. A peculiar position has arisen in the market for re-melted spelter. The quantities produced in this country are not sufficient to meet requirements, and as imported metal is subject to a duty, prices have advanced to £16 5s. to £17.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— *(D/d Teesside Area)*		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— *(Delivered to Black Country Station)*		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	
Forge	3 1 0	
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

(Basic iron prices subject to a rebate of 5/–.)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 10 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 15 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/6 to 16/9.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½ per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, November 29th.

COPPER—		
Cash	£29 11 3 to £29 12 6	
Three months	£29 15 0 to £29 16 3	
Electrolytic	£32 15 0 to £33 15 0	
Best Selected Ingots, d/d Birmingham	£33 15 0	
Sheets, Hot Rolled	£60 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9¾d.	9¾d.
„ Brazed (basis)	9¼d.	9¼d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	8¼d.	8¼d.
„ Brazed	10¾d.	10¾d.
TIN—		
Cash	£225 10 0 to £225 12 6	
Three months	£225 12 6 to £225 15 0	
LEAD:	£11 11 3 to £11 15 0	
SPELTER:	£14 15 0 to £15 0 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 13/–
„ Glasgow— Ell	12/9 to 15/–
„ „ Splint	16/– to 16/6
AYRSHIRE	
(f.o.b. Ports)—Steam	12/6 to 12/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/6 to 14/6
Unscreened Navigation	12/3 to 13/–
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	13/6
Secondary Steam	13/–

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
NORTHUMBERLAND—	
Blyth Best	13/9 to 14/–
„ Second	12/9 to 13/–
„ Best Small	10/–
Unscreened	11/6 to 12/6
DURHAM—	
Best Gas	14/8
Foundry Coke	17/– to 18/6

SHEFFIELD—	Inland.	
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	6/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	17/9 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	19/– to 36/–
Furnace Coke	16/– to 17/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	10/– to 11/–
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

French Trade Policy.

THE policy of trade restrictions and reprisals which has seriously disturbed foreign commercial relations during the past few years has had the effect of reducing this country's exports to about two-fifths of what they were four years ago. The fall in the monthly returns is continuous and threatens to reach a level at which exports will count little as a factor in the country's economic prosperity. Attempts to "adjust" the conditions of production costs abroad to those existing here, by means of expedients such as the compensating tax and turnover tax on goods imported, and incidentally to raise more money for the Treasury, have had no other effect than to close up the channels to French trade. Successive Governments have endeavoured in their different ways to give satisfaction to conflicting industrial and commercial interests, and have only succeeded in eliminating exporting industries without providing activity to the home trade. The decision of the British Government to impose an additional duty of 21 per cent. on certain imports from France so long as this country maintains the compensating tax of 15 per cent. and the turnover tax of 6 per cent. has brought matters to a head, and will necessitate the withdrawal of the French from an impossible situation or will, in the words of one authority, "strike a death-blow at French trade with Great Britain." The situation has been rendered impossible by the insistence with which the French claimed commercial concessions in return for a suppression of the compensating tax. The idea of this compensation has been general, even amongst exporters who are suffering from its effects upon trade with Great Britain, and a final attempt to obtain concessions was to have been made by the late Minister of Commerce, Monsieur Laurent Eynac, who had, nevertheless, to cancel his proposed visit to Mr. Runciman as the result of a diplomatic intimation that any discussion on this subject was undesirable. The British ultimatum arrived at a time of political crisis, and nothing can be done until the new Government gets to work; but in view of the seriousness of the situation, from the point of view of exporting industries, it is not improbable that the prospect of an exclusion of French products from Great Britain will modify the future trade policy of this country.

Compagnie Generale Transatlantique.

With the appointment last week of the board of directors, the Compagnie Générale Transatlantique was definitely constituted on new lines, which give to the State a majority of voting power with ten members, while shareholders have appointed six members to represent them, and there remain two others to be elected respectively by the office staff and the officers and seamen. The company has, in fact, become a State organisation, with the collaboration of shareholders and workers, who can obviously take no effective part in the decisions arrived at by the majority. The State control was imposed on account of the considerable financial assistance it had rendered in order to prevent the company from foundering, and also because the necessity of paying subsidies gave a claim to the State to see that the company is properly administered. Of the directors representing the State, four are financial experts. The State has therefore taken upon itself a responsibility for the Compagnie Générale Transatlantique which will, no doubt, be regarded by investors as offering a guarantee when the new share issue is made. Nevertheless, its control of a commercial enterprise does not meet with general approval. It is accepted because, without State intervention, the Compagnie Générale Transatlantique would infallibly have gone into liquidation.

Import Licences.

The system under which import licences are granted has already given rise to considerable trouble, particularly for coal, and it will become an absurdity if the Government carries out its proposal to put licences up to auction with the object of raising funds for the payment of subsidies to farmers. The latitude allowed to responsible groups in different countries to distribute licences allotted to them will, according to the proposed arrangement, be withdrawn, and the French Department of Commerce will itself grant licences to the highest bidders amongst a selected list of importers. The immediate result of this system will inevitably be to create monopolies and to increase prices to consumers. Opposition to the scheme is so general that it is doubtful whether the Government will persist in a plan which, it is said, is bad in itself and may provoke reprisals from other countries. The reduction of the import quota for coal by 10 per cent. is also severely criticised. Consumers object to pay more for coal in order to keep a very small proportion of the working population in employment, and it is suggested that the far greater class of operatives in ironworks, factories, and shops which must have cheap coal, as well as dockers and others interested, should combine and agitate as strenuously for the abolition of the import quotas as the miners do to maintain them.

The Steel Cartel.

At a meeting of the Steel Cartel in Paris last week the difficulties that threatened the withdrawal of the Forges de Clabecq at the end of the year were removed by the Belgian "Cosibel" group making concessions to Clabecq, which is understood to have agreed to continue its association with the International Steel Union. The firm was offered the greater part of an order for sheets from Russia. This incident indicates an element of weakness in the situation of the Cartel, in view of the fact that a sheet rolling firm like Clabecq was deprived of its special competitive advantages. Another matter that may affect indirectly the Cartel is the possibility of an understanding between German and Polish steel makers, who are reported to be endeavouring to find a basis for collaboration, particularly in the way of giving more vitality to the steel industry in what was formerly Upper Silesia. Poland has refused to adhere to the Steel Cartel on the ground that it was not satisfied with the quota offered.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

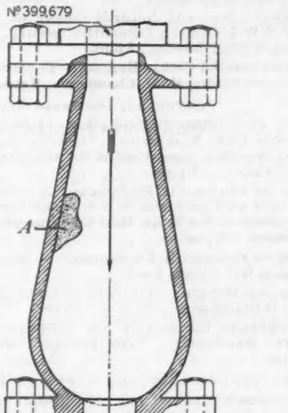
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

399,679. December 16th, 1932.—DEVICES FOR PREPARING FUEL-AIR MIXTURES FOR INTERNAL COMBUSTION ENGINES, D. N. Hapkins, 109, South Carondelet-street, Los Angeles, California.

This mixer is intended to be arranged between the carburettor and the inlet manifold, and depends for its action on the changes in velocity and pressure caused by passing the gases through a divergent-convergent passage. As shown, the passage starts with a conical form and ends as a hemisphere. It is recommended that the length of the conical part should be 77 per cent., and the radius of the hemisphere 23 per cent. of the total length. It is also suggested that the interior surface should be roughened as shown at A.—*October 12th*, 1933.

No 399,679



DYNAMOS AND MOTORS.

399,832. April 4th, 1932.—SYSTEMS FOR CONTROLLING ELECTRIC MOTORS, William Train Gray, of "Darroch," Wainwright-road, Altrincham, Chester, and Associated Electrical Industries, Ltd., of Crown House, Aldwych, in the City of Westminster.

A system is described in this specification for controlling electric motors and has for its object to provide improved arrangements whereby compound wound direct current motors can be connected in series or in parallel, the transition from series to parallel connection being effected by what is commonly known as the short circuit method. The motor armatures are indicated at A, B, and their respective series field magnet windings at C, D. The positive terminal of the supply is indicated at E, and earth at F. G is the line switch. H is an accelerating or decelerating resistance provided with the usual short-circuiting switch J, so that it can be included in the circuit of the motors, whether they are in series or parallel. The "series" switch by which the two motors are connected together in series when the circuit is closed is indicated at K, and L and M are the switches by which the motors are connected in parallel, L being called the "parallel" switch and M the "earth" switch. The shunt field magnet windings for the motors are not shown. The transition resistance O is included in series with the series switch K, and is provided with a short-circuiting switch P. In effecting the transition from series connection of the motors to parallel connection the sequence of operations is as follows. In the full series connection of the motors switches G, J, P and K are closed, and the circuit is from the supply E, switch G, switch J, armature A, field winding C, switch P, switch K, armature B, field winding D, and earth F. To change to parallel operation switches J and P are opened and the parallel switch L and the switch M are closed, thereby connecting the motors in parallel and shunting them directly by the resistance O. The series switch K is then opened so as to break the circuit through the resistance and leave the motors connected in parallel. Switch J can then be closed so as to short circuit the resistance H if desired. In changing the connections of the motors from parallel to series the sequence of operations above described will be carried out in the reverse order.—*October 4th*, 1933.

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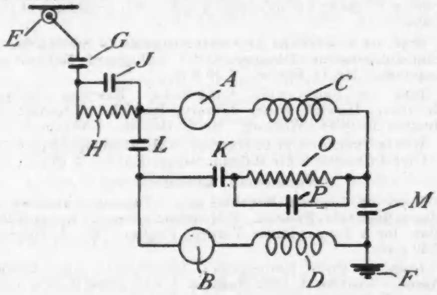

TRANSMISSION OF POWER.

399,215. April 1st, 1932.—TERMINAL DEVICES FOR ELECTRIC CABLE SYSTEMS, Siemens Brothers and Co., Ltd., of Caxton House, Tothill-street, Westminster, London, S.W.1; and Henry Gurney Wood, of "Kinross," Leesons-hill, Chislehurst, Kent.

In some high-tension systems the cable is subjected to pressure exerted by a pressure medium, *e.g.*, gas, in the cable duct or the interior of the cable is under pressure, such as in the oil-filled system. In both cases the cable accessories must be connected to a source of pressure and conveniently oil under pressure is used as the pressure medium. In an ordinary electric cable system a multi-core cable, when it is to be terminated, is generally introduced into a dividing box which is provided with insulated terminals. Where, however, the dividing box contains a medium such as oil under pressure other considerations arise. One feature of the invention is that the several cores of a multi-core cable are terminated in separated end sealing devices and provides an improved arrangement whereby operations can be carried out on any one of the sealing devices without the others being affected, the sealing ends being connected to the cable through a dividing box closed by being connected to the cable at one end and to single-core tail pieces at the other end. The cable A is led into a dividing box B through a diaphragm C, which may itself incorporate or may have attached to it a flexible coupling D which takes up strains to which the lead sheathing of the cable is subject. In the dividing box the cable cores E open out and the individual cores are jointed to tail pieces F of lead-sheathed cable. Plumbed to the tail pieces, as at G, are pipes of copper or other non-ferrous metal, which pass through sleeve-like bosses J on the cover K of the dividing box. The ends of the pipes H which are outside the dividing box are plumbed, as at L, to the bosses. The sealing bells are plumbed, as at M, to the ends of the pipes and the tail pieces are connected to the terminals mounted on the bells. When the parts are assembled and closed the dividing box B is filled with oil or compound under pressure from an external source and also the sealing bells, the pressure being separately maintained by means of tubes P for each of the bells and dividing box. Each tube is provided with a valve R so that any of the bells or the dividing box can be isolated from the source of pressure.—*October 2nd*, 1933.

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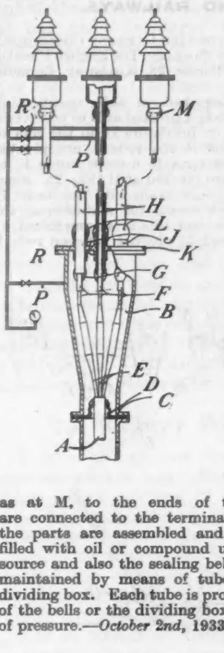

MACHINE TOOLS AND SHOP APPLIANCES.

399,773. September 12th, 1932.—PNEUMATIC HAMMERS, F. Hills, 45, Airthrie-road, Goodmayes, Ilford, Essex.

This is a rubber buffer to prevent damage to the hammer in the event of the tool not being held up to its work. The rubber buffer is shown at A and is held in the cap B, which is secured to the body of the tool by through bolts. The tool chuck C is provided with a flange which bears on the top of the buffer. In the absence of the resistance of the tool D, the hammer E drives the anvil F against the chuck and the blow is taken up by the buffer.—*October 12th*, 1933.

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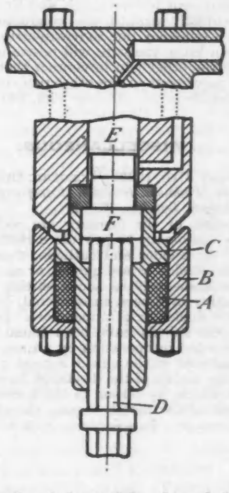

FURNACES.

400,020. December 19th, 1932.—ELECTRIC FURNACES, Société Anonyme des Manufactures des Glaces et Produits Chimiques de St. Gobain, Chauny and Cirey, of 1bis, Place des Saussaies, Paris.

The electric furnace described in this specification is for fusing metals of high melting point. In Figs. 1 and 2 the resistor is constituted by a straight rod A of carbon or graphite, the ends of which are supported in sleeves B carried by movable plates C,

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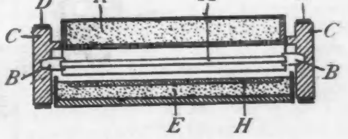

Fig. 1

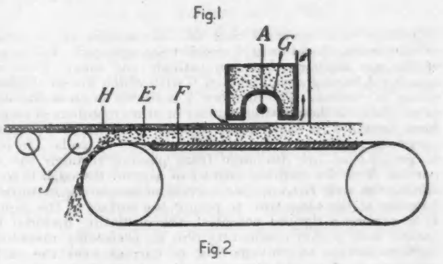

Fig. 2

also of carbon. These plates are fixed in metal frames D, which are connected to the terminals of a current source. The primary material E to be fused is distributed in a pulverulent state on a conveyor F, which causes it to pass below the heating apparatus constituted by the resistor A and the chamber G at a speed of displacement regulated so as to fuse a predetermined thickness of the material. The plate H thus fused travels on rollers J, while the pulverulent bed remaining unfused is removed at the end of the horizontal course of the conveyor. The material shown at K is heat insulation.—*October* 19*th*, 1933.

TRAMWAYS AND RAILWAYS.

400,151. July 17th, 1933.—PANTOGRAPH CURRENT COLLECTORS FOR ELECTRIC RAILWAYS AND THE LIKE, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C.2.

The pantograph (Fig. 1) described in this specification comprises a framework of lower rods A pivoted at B to transverse axes on a framework C carried on insulators D on the roof of the vehicle. To the upper ends of the rods A are pivoted rods E pivoted together at their apex to a cross frame F, to which the pan-carrying arms G are pivoted at H (Fig. 2). Since the arms G do not form a rigid connection with the frame F, it is necessary to provide other means for maintaining the frame in position about its axis, and this is accomplished by means of the links J (Figs. 2 and 3) pivoted between rods E and ears on a boss L, which slides on a rod M secured to the frame F. The lowered position of these parts is shown in the detail view, Fig. 3. Collector pans N are carried by the outer ends of the arms G, and may be either pivoted or fixed rigidly. The inner ends of the arms adjacent to the pivots are provided with right-angled extensions O, Fig. 2, between which there is a spring tending to force the projections O apart, the one acting as the abutment for the other, and thus tending to hold each pan individually against the conductor wire. In this manner, whilst a tendency due to irregularity in the conductor to make one pan leave the wire will create a greater pressure tending to hold the other pan in contact therewith, it will not give a positive movement to the other pan equal to that of the pan which leaves the wire.—*October* 19*th*, 1933.

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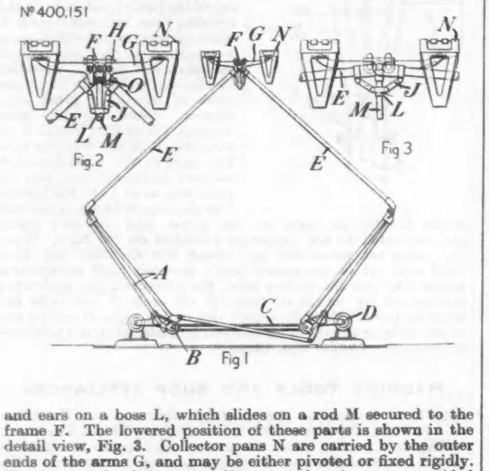

MISCELLANEOUS.

399,498. February 27th, 1932.—ELECTRIC DISCHARGE DEVICES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

In the operation of the mercury arc rectifier and similar apparatus, it is customary to provide metallic members interposed between the anodes and cathode, these members functioning as anode shields or arc guides, or as control electrodes or grids, or simultaneously as anode shields and control electrodes. Difficulties have been encountered, however, in the use of these metallic shields or grid members. In many instances, for example, steel shields have been found to be perforated and heavily corroded in operation by an arc discharge passing through the material of the shield instead of around its edge to the anode, this action of the discharge forming on the shield a cathode spot which, by reason of the condensation upon the associated anode of the metal, vapour thereby formed caused arc back of this anode. In accordance with the invention, these difficulties are overcome and the advantages of a metallic or conducting shield or grid member are retained. In the path of the arc discharge between cathode and anode there is a member A having a wall portion B with which the arc discharge comes in contact. The member A is shown as an anode shield or arc guide, although this member or other members of suitable form mounted in any suitable manner may be used for other purposes, particularly as control electrodes or grids. In order to prevent an arc discharge from passing through the wall portion B of the member instead of around the edge C to the anode, the wall B comprises a body of insulating material D. In order at the same time to permit the surface of the member B to assume a desired potential, the insulating material D is coated with a thin conducting film E, preferably metallic, of high resistivity to prevent flow of current over the surface sufficient to cause the formation of cathode spots.—*September* 27*th*, 1933.

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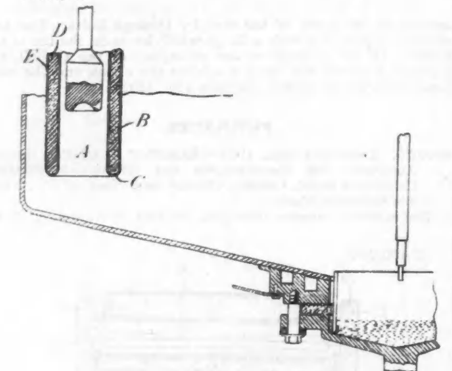


Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Thomas Lowe Gray Lecture, "High-speed Diesel Engines for Marine Service," Mr. H. R. Ricardo, F.R.S. 6 p.m.

INST. OF MECHANICAL ENGINEERS: GRADUATES.—Carr's Restaurant, Strand, W.C.2. Smoking concert.

INST. OF SANITARY ENGINEERS.—At Abercorn Rooms, Great Eastern Hotel, Liverpool-street, E.C.2. Annual dinner. 6.45 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Dairy Machinery and Plant," Mr. W. Chopping. 7.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS.—In Mining Inst., Newcastle-upon-Tyne. "The Electric Welded Ship 'Peter G. Campbell,'" Mr. N. M. Hunter. 6.p.m.

PHYSICAL SOC.—At Imperial College of Science and Technology, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 5 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. —Discourse by Mr. R. M. Chambers. 9 p.m.

SATURDAY, DECEMBER 2ND.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Engineers' Club, Manchester. "Unorthodox Methods of Commercial Moulding Sand Control for the Modern Ironfounder," Mr. F. Hudson. 4 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—Joint visit with graduates of N.E. Coast Inst. of Engineers and Shipbuilders to the Pelaw Main Collieries coal-washing plant at Wrekenton. 3 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to B.B.C. House, Leeds.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—Midland Hotel, Birmingham. Dinner and dance. 7 p.m.

STEPHENSON LOCOMOTIVE SOC. (MIDLANDS).—At Crumpsall Library, Manchester. "The Liverpool Overhead Railway. 6.30 p.m.

MONDAY, DECEMBER 4TH, TO FRIDAY, DECEMBER 8TH.

SMITHFIELD CLUB SHOW.—At Royal Agricultural Hall, Islington, N.1. 9 a.m. daily.

MONDAY, DECEMBER 4TH.

CHARTERED SURVEYORS' INST.—12, Great George-street, S.W.1. "The Law Relating to Electricity Supply," Mr. H. F. Bidder. 8 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Rendezvous Restaurant, Pilgrim-street, Newcastle-upon-Tyne. Informal meeting. Discussion, "Electricity as a Heating and Warming Agent," opener Mr. L. E. Mold. 7 p.m.

INST. OF PRODUCTION ENGINEERS: SHEFFIELD SECTION.—Royal Victoria Hotel, Sheffield. "Optical Measurement in Engineering Production," Mr. A. A. Gigli. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. General meeting. 5 p.m.

SOC. OF CHEMICAL INDUSTRY.—At Chemical Soc., Burlington House, W.1. "Control and Measurement of Temperature in an Industrial Laboratory," Messrs. E. A. Cooke and J. C. Swallow. 8 p.m.

SOC. OF ENGINEERS.—At Geological Soc., Burlington House, W.1. "Reinforced Concrete: Its Application to Modern Housing," Mr. H. Kaylar. 6 p.m.

TUESDAY, DECEMBER 5TH.

CHADWICK PUBLIC LECTURES.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Rural Sanitation," Mr. J. H. Coste. 8 p.m.

CHELSEA POLYTECHNIC.—Manresa-road, S.W.3. Distribution of prizes, diplomas, and certificates to students by the Viscount Leverhulme. 8.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Technical Aspects of the Design of the 'Blue Bird' Racing Car," Mr. R. A. Railton. 7.45 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At N. British Station Hotel, Edinburgh. Dinner, 6.30 for 6.45. Prof. F. G. Baily will introduce a talk, "Reminiscences of Early Days."

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Shipyard Methods and Lay-outs," Mr. G. Barrie. 7.30 p.m.

INST. OF PRODUCTION ENGINEERS: EASTERN COUNTIES SECTION.—Ipswich Public Library, Ipswich. "Modern Production Acetylene Welding," Mr. C. Helsby. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Liquid Crystals," Sir William Bragg, F.R.S. 5.15 p.m.

WEDNESDAY, DECEMBER 6TH.

INST. OF BRITISH FOUNDRYMEN: PRESTON SECTION.—In Harris Institute, Preston. "Moulding a Crank Case and Baseplate for a Four-cylinder Vertical Engine," Mr. J. Robinson. 7.30 p.m.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—Visit to L.M.S. Railway Locomotive Works, Crewe. Leave New-street, Birmingham, 11.45 a.m.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Savoy-place, W.C.2. "The Spontaneous Background Noise in High-gain Receivers Due to Thermal Agitation and Schrott Effects," Messrs. E. B. Moullin and H. D. M. Ellis. 6 p.m.

INST. OF MECHANICAL ENGINEERS: N. WESTERN BRANCH.—(Joint meeting with the Liverpool Engineering Soc., Liverpool.) Thomas Lowe Gray Lecture, "High-speed Diesel Engines for Marine Service," Mr. H. R. Ricardo, F.R.S. 7.15 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Radiometric Condensers and Inductances," Mr. G. G. Blake. 8 p.m.

THURSDAY, DECEMBER 7TH.

CHEMICAL ENGINEERING GROUP.—Joint meeting with Bristol Section. Visit to the Bristol Pottery at Fishponds, 2.30 p.m. Meeting at University of Bristol, "British Chemical Stoneware," Mr. G. N. Hodson, 6.45 p.m. Informal dinner at Hart's Restaurant, Broad-street, Bristol, 8.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Queen's Hotel, Birmingham. "Repairs," Mr. J. Dent. 8 p.m.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. "Application of Automatic Voltage and Switch Control to Electrical Distribution Systems." Messrs. W. Kidd and J. L. Carr. 6 p.m.

INST. OF MECHANICAL ENGINEERS: N. WESTERN.—Engineers' Club, Manchester. "Factors Affecting the Grip of Force, Shrink and Expansion Fits," Mr. R. Russell. 7.15 p.m.

INST. OF METALS.—At James Watt Memorial Inst., Birmingham. "The New Copper Refinery at Prescot," Mr. D. W. Aldridge. 7 p.m.

INST. OF METALS: LONDON LOCAL SECTION.—Joint meeting with Inst. of British Foundrymen, in the Rooms of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "A Metallurgist's Outlook on Modern Foundry Productions," Mr. J. R. Handforth. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Properties of Concrete—A Summary of Present-day Information," Mr. J. Singleton-Green. 7 p.m.

FRIDAY, DECEMBER 8TH.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND STUDENTS.—Boots' Café, Colmore-row, Birmingham. Annual dance.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Discussion, introduced by Mr. A. Perry-Keene, "Shop Organisation." 7 p.m.

JUNIOR INST. OF ENGINEERS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. Presidential address, "Newton's Third Law of Motion and Some Dynamics," Mr. W. J. Tennant. 7.45 p.m.

INST. OF METALS.—In the Non-ferrous Section of the Applied Science Dept. of the University, Sheffield. "Modern Application of Electric Heat," Mr. J. C. Howard. 7.30 p.m.

INST. OF PRODUCTION ENGINEERS: WESTERN SECTION.—Merchant Venturers' College, Bristol. "Modern Production Acetylene Welding," Mr. C. Helsby. 7.30 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Signalling, Remote Control," Mr. Edward Wallis. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "The Making of a Sheet of Glass," Major R. M. Weeks. 9 p.m.

FRIDAY AND SATURDAY, DECEMBER 8TH AND 9TH.

BOROUGH POLYTECHNIC.—Borough-road, S.E.1. Exhibition of students' work. Friday, 6 to 9 p.m.; Saturday, 2.30 to 9.30 p.m.

SATURDAY, DECEMBER 9TH.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. Junior Section's social and dance. 7.30 p.m. to 11.15 p.m.

STEPHENSON LOCOMOTIVE SOC.—Headquarters, King's Cross Station, N.1. Annual general meeting, 3 p.m., Midland Grand Hotel, St. Pancras, N.1. Annual dinner, 6.30 p.m.

MONDAY, DECEMBER 11TH.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Verbesserung von Schiffsgrundrissen (Improvement of Ships' Sections)," Herr Dr.-Ingenieur Eberhard Westphal, of the Technische Hochschule, Danzig. The lecture will be followed by a technical discussion in German. 5.30 for 6 p.m.

INST. OF METALS.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "The Use of Fluxes and Slags in Non-ferrous Foundry Practice," Mr. T. Tyrie. 7.30 p.m.

TUESDAY, DECEMBER 12TH.

INST. OF AUTOMOBILE ENGINEERS.—At King's Head Hotel, Coventry. "Technical Aspects of the Design of the 'Blue Bird' Racing Car," Mr. R. A. Railton. 7.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "Transmission Principles," Mr. L. H. Pomeroy. 7 p.m.

INST. OF BRITISH FOUNDRYMEN: BURNLEY SECTION.—Municipal College, Burnley. "Developments in Foundry Refractories," Mr. E. J. Crawley. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Hotel Metropole, Leeds. "Problems Night." 7.15 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At N. British Station Hotel, Edinburgh. Mr. N. C. Bridge will open discussion on "The Costing of Production at Selected Stations." 7 p.m.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. "Notes on the Manufacture of Piston Rings and their Relation to Liner Wear," Mr. H. J. Young. 6 p.m.

INST. OF MECHANICAL ENGINEERS: N. WESTERN BRANCH, GRADUATES.—Engineers' Club, Manchester. "Bauer Wach Exhaust Steam Turbines," Mr. E. Crossley. 7.15 p.m.

INST. OF METALS.—Y.M.C.A., Swansea. "Exhibition of Industrial Films. 6.15 p.m.

INST. OF METALS: N. EAST COAST LOCAL SECTION.—Joint meeting with Inst. of British Foundrymen, Armstrong College, Newcastle-upon-Tyne. "Addition of Non-ferrous Metals to Cast Iron," Mr. J. E. Hurst. 7.30 p.m.

WEDNESDAY, DECEMBER 13TH.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—At Old Bell Restaurant, Holborn. Annual dinner. 7 p.m.

THURSDAY, DECEMBER 14TH.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—Queen's Hotel, Birmingham. Annual dinner. Reception, 6.30 p.m.; dinner, 7 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—The Minories, E.C.3. Film display, I., "The River Tyne," II., "The World of Machinery at the Leipzig Engineering Fair." 7 p.m.

FRIDAY, DECEMBER 15TH.

INST. OF CHEMISTRY.—30, Russell-square, W.C.1. Fifth S. M. Gluckstein Memorial Lecture. "The Chemist as a Directing Force in Industry," Dr. Herbert Levinstein. 8 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 for 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Discussion, "Heat Transfer between Metal Pipes and a Stream of Air," Dr. Ezer Griffiths and Mr. J. W. Awbery. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "General Principles Governing Cable Network, Design and Maintenance in Large Towns," Mr. E. W. Carline Day. 8.30 p.m.

RAILWAY CLUB.—Broad-street Station Restaurant, E.C. Annual dinner.

SATURDAY, DECEMBER 16TH.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to Messrs. Marshall, Kay and Marshall, Dewsbury. 3 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—At College of Technology, Manchester. Conversazione and dance. Reception 6.45 p.m.

MAIN LINE OIL-ELECTRIC LOCOMOTIVE.—In order to avoid any misunderstanding, Sir W. G. Armstrong, Whitworth and Co., Ltd., ask us to state that the main line oil-electric locomotive, described in our issue of November 17th, has not been purchased by the London and North-Eastern Railway, as might be inferred from the title of our article, but is being put into a regular trial service on that railway.

"BRITISH RUSSIAN GAZETTE" LUNCHEON.—At the fifth *British Russian Gazette* luncheon, which will be held on Thursday, December 7th, 1933, at 12.45 p.m. for 1 o'clock, at the Connaught Rooms, Sir Francis Goodenough will give an address on "Trade with Russia." This luncheon is being arranged for business men and manufacturers in order to further the development of British trade with Russia. Intending guests are asked to make application for tickets not later than December 4th to the British Russian Gazette and Trade Outlook, Ltd.

A Seven-Day Journal

Railway Contracts.

The Great Western Railway Company, which is the biggest user of steel sleepers in the country, has decided to lay a further 27 miles of track with them. Orders have been placed with Guest, Keen and Nettlefolds, Ltd., for 100,000 steel sleepers, weighing 10,500 tons, 10,000 tons of chairs and 25,000 tons of steel rails. The Lancashire Steel Corporation, Ltd., has also received an order for 5000 tons of steel rails. These orders represent a total of 50,000 tons of steel for use during the company's 1934 relaying programme. It has already 400,000 steel sleepers laid in its main, relief, and branch lines, equal to 185 miles of track, in the following districts:—London, Bristol, Thornton, Plymouth, Newport, Cardiff, Neath, Gloucester, Wolverhampton, Shrewsbury, and Oswestry. The Southern Railway Company announced on Monday last, December 4th, that work will be at once begun on a second pair of passenger and cargo sheds at the new Southampton Docks. The sheds will have a length of 1274ft. The contract for steel work has been let to E. C. and J. Keay (1926), Ltd., of Birmingham, and a contract for walls, roofs, &c., with Sir Robert McAlpine and Sons, of London. The cost of the new sheds will be about £50,000 and their construction will employ about 400 men during the winter months.

The Merchant Navy.

In the House of Commons, on Thursday last, November 30th, Lieutenant-Colonel Moore-Brabazon presented a petition drafted under the auspices of the Officers (Merchant Navy) Federation, asking that a public inquiry be set up to report upon the conditions of service of certificated navigating and engineer officers in the British merchant navy. The petition, which was signed by over 12,500 masters, navigating and engineer officers, and by over 10,000 members of the public, was brought to Westminster on the tug "Britannia," which came up the river to Westminster Pier. It prays "That the well-being of the merchant navy, being a matter of national concern, a public inquiry be set up to report upon conditions of service of certificated navigating and engineer officers in the British merchant navy, with special regard to training, contract of employment, leave, remuneration, unemployment and health insurance, representation, recognition, employment of uncertificated and foreign officers in British ships, benevolent work and pensions, and the provisions of the Merchant Shipping Acts, 1894 to 1921, in so far as such Acts affect certificated officers." The question is also to be raised in the House of Lords.

The Forth Road Bridge.

In a Journal note of October 6th we outlined the proposals of the Minister of Transport with regard to the construction of a road bridge over the river Forth from Kincardine-on-Forth to Higgins' Neuk. It may be recalled that the Ministry of Transport will give a grant of 75 per cent. of the estimated cost of £327,000. Work has now been begun on the bridge, the contract for the construction having been let to the Cleveland Bridgebuilding and Engineering Company, Ltd., of Darlington. Over 4000 tons of steel will be used in the structure. The bridge has been designed by Sir Alexander Gibb and Partners and will have twelve spans, each of 50ft., with a horizontal swing span in the navigable channel of the Forth, providing two openings for shipping, each of 150ft. clear width with about 30ft. clear headroom at high water. The roadway has a total width of 40ft. over parapets and comprises a 30ft. carriageway with 5ft. footpaths on either side. The spans will be supported on cylinders of reinforced concrete sunk into the river bed. At the end of last week the engineers and contractors surveyed the site and it is expected that the work of excavation will begin before Christmas. The new bridge will be approached on either side by easy gradients from the arterial roads on either side of the bridge. When completed, the new bridge will reduce the mileage between Glasgow and Fife by one third, and it will avoid the congested roads near the town of Stirling.

The Smithfield Club Show.

Following our usual practice, we paid a visit to the annual Show of the Smithfield Club, commonly known as the "Cattle Show," which opened at the Royal Agricultural Hall on Monday, the 4th, and closes to-day. As most engineers know, the Show provides an occasion when engineers manufacturing agricultural machinery can display their products to advantage, for interested visitors come from all over the country and are not greatly incommoded by the sight-seeing public. All the marginal space of the two halls and the gallery is given up to machinery and implements, and in the past good displays have been provided. This year, however, the Show is disappointing from an engineering point of view. Apart from the absence of several firms which have exhibited for many years past, but have recently gone out of existence, there are many absentees, and there is only one stand which retains its familiar appearance. There are to be seen one or two other names that are known throughout the engineering world, but several of them have become hyphenated. The result of the absence of the heavier engineering firms is that the makers of agricultural implements, windmills, and the like have encroached greatly on the space. The makers of small refrigerating plant also are much in evidence, fostered, of course, by the new food preservation regulations. It is rather remarkable that electrical farming appliances—that is to say, for the application of electrical power to general purposes—are not represented, as we are led to believe that the policy of the Central Board is to foster the use of electricity on the land. There are certainly a few appliances, such as milking machines and refrigerators driven by electric motors, but there is no evidence of concerted action to encourage the policy. There is one other characteristic about the Show and that is the advent of the pneumatic tire for farm vehicles. It is even, in two cases, fitted to oil tractors. Track-tractors are also represented, and there is a new tractor wheel equipped with spuds specially shaped for getting a maximum grip in soft ground.

Industrial Psychology.

Two investigations in engineering factories are described in the annual report of the National Institute of Industrial Psychology, which has just been issued. In the first works, which manufactures motor accessories, the Institute tackled the problem of installing a new system of stock control, better suited to the needs of the factory than the old system. It also investigated in detail the service offered to customers at the factory service depôt, compiling a booklet of service notes for reception clerks which, it is hoped, will enable them to avoid most of the awkward situations which are liable to arise with customers. The methods of staff management adopted when two shops in the factory were amalgamated had produced unsatisfactory relations between the various grades of employees. The Institute was successful in removing the friction and discontent, mainly by improving the methods of staff control. The Institute is also working in the repair factory of the Post Office Stores Department. Here the problems are concerned mainly with congestion of space and the strained postures of the men working on certain types of apparatus. The Institute has planned new lay-outs, and it has constructed storage cabinets and adjustable tool holders so that all the things required on the job are ready at hand. It has recommended the use of platforms so that the men need not stoop so much in the course of their work.

The Unemployment Returns.

As normal seasonal effects usually result in a decline of employment in the month of November, it is all the more gratifying to find from the returns of the Ministry of Labour that in November there were 31,000 more persons at work than during the preceding month. As compared with the corresponding month a year ago, the figures show a decrease of unemployment by as much as 597,000. On November 20th, 1933, the numbers of unemployed persons on the registers of employment exchanges in Great Britain were 1,855,808 wholly unemployed, 340,135 temporarily stopped, and 84,074 normally in casual employment, making a total of 2,280,017. Apart from such trades as building, public works contracting, &c., which are normally adversely affected in November, the improvement is general. Coal-mining, cotton, iron and steel, and general engineering all show substantial decreases in unemployment, and the figures for shipbuilding and pottery also exhibit a good, though not so large a decline. One of the features of the returns is that increase in employment is particularly noticeable in the Midlands and the North of England.

The Navy and Coal Fuel.

From time to time we have referred in these columns to the Back-to-Coal Movement, and particularly to the desire of South Wales coal producers to see the Navy revert to coal firing. In a written answer to a question in the House of Commons last week, Sir Bolton Eyres Monsell, First Lord of the Admiralty, stated that none of his Majesty's ships is fitted to burn alternatively oil or coal, and that, in view of the many disadvantages attendant upon the use of a dual system from the standpoint of Fleet efficiency, it is impossible for the Board of Admiralty to adopt such a system, either for present or future vessels. The Minister said that the use of coal by the Navy had been frequently considered from the standpoint of the coal industry, but that even if the Navy was to burn coal exclusively, its consumption would not exceed ½ per cent. of the total national output of coal. It has since been pointed out, however, that while the figure given by Sir Eyres Monsell is true, the coal consumed by the Navy would be best steaming coal, and should be more properly related to the output of that particular class of coal, which is about 30,000,000 tons p.a. On this basis, naval requirements would involve one-thirtieth of the national output, and would find permanent employment for over 3000 miners. The cost of converting the present oil-fired system used in the Navy to coal-firing is estimated by the Minister as at least £35,000,000.

A Famous Clyde Steamer.

On Thursday, November 30th, the well-known L.M.S. Clyde passenger steamer, "Caledonia," carried through her final sailings. For many years she has been employed on the service between Gourock and the Holy Loch piers, and as she left these piers on Thursday afternoon, farewell blasts were blown on the siren. On arrival at Gourock, she disembarked her final complement of passengers and proceeded to Albert Harbour, Greenock. In due course she will probably pass into the hands of the shipbreakers. Meanwhile, her service has been taken up by the steamer the "Marchioness of Breadalbane." The "Caledonia" was built in 1889 to the order of the Caledonian Steam Packet Company for service between Gourock and the coast resorts by John Reid and Co., of Port Glasgow, and was engined by Rankin and Blackmore with tandem compound diagonal engines, supplied with steam at 99 lb. pressure from two Navy-type boilers working under forced draught. The hull has a length of 200ft., a beam of 22ft., and a depth of a little over 7ft. The "Caledonia" retires after over forty years' service.

A Railway Wagon Census.

At four o'clock on Sunday, December 3rd, a periodical census was taken of the 650,000 or more railway-owned wagons in service at every station, goods depôt, and siding in Great Britain, and the 362,000 sheets which are provided for covering open wagons. Special staffs were employed, which patrolled the whole of the 51,000 miles of British railway track, each man being assigned a definite section. Special provision was made for the wagons actually in transit at four o'clock when the census was taken. On the London, Midland and Scottish Railway the total census included some 300,000 vehicles and over 150,000 railway-owned sheets, for which it was necessary to issue 23,000 census forms to the railway staff. The returns of the census are made to headquarters, where they are checked, in order to enable the necessary disposition of rolling stock between the different railway companies to be made by the Railway Clearing House.

Southern Railway Electrification.

On Tuesday last it was announced that the Southern Railway Company had decided to extend its main line electrification scheme from Wivelsfield and Brighton to Eastbourne and Hastings, and from Haywards Heath to Horsted Keynes, at a cost of £1,750,000. The work will be put in hand almost immediately and the extension is expected to be ready for operation early in 1935. By the use of electric traction it will be possible to increase the train mileage over these lines by some 45 per cent. The equipment of the new sections will be generally similar to that employed on the Brighton and Worthing sections of the line, and British firms will benefit considerably from the contracts which will be placed. The new rolling stock which will be required will include seventeen six-car units, five four-car units, and eighteen three-car units, with the necessary Pullman stock. The longer trains to be employed will necessitate platform extensions at London Bridge, Lewes, and Eastbourne, and alterations to the permanent way at Bexhill Central. When the work has been completed the Southern Railway Company will have 442 miles of electrified lines with a track mileage of 1146. It is also announced that the Southern Railway Company will apply to Parliament during the present session for powers to construct a new loop line between Folkestone and Dover.

Return of the Royal Scot.

On Tuesday, December 5th, the "Royal Scot" arrived at Tilbury from Canada on the Canadian Pacific cargo liner "Beaverdale." After being renovated and refitted at Crewe the train, which has made such a successful tour of the United States and Canada, will be given an official welcome at Euston Station. According to Mr. C. O. D. Anderson, who was in charge of the train throughout the tour, all who inspected it were impressed by the superiority of British workmanship. At the end of her tour the engine, after running over 11,190 miles, was in as good condition as when she started, and could be running again in five days. North American engineers were particularly impressed, Mr. Anderson stated, with the absence of any mechanical breakdown, and the fact that on arrival at a station after a run there was no necessity to go round greasing dangerously heated bearings. Grease lubrication is generally employed both on Canadian and American locomotives, but it is noteworthy that since the visit of the "Royal Scot" the Canadian Pacific Railway Company has adapted a locomotive for oil lubrication. During the tour the train was inspected by no less than 3,021,601 people, and over 500 electric light bulbs were carried away as souvenirs, while more than 1000 signatures were scribbled on the roofs of the carriages; hence the need for renovation and refitting before the official reception.

Vertical-Lift Drawbridges.

By E. E. R. TRATMAN.

No. I.

A TYPE of drawbridge which has come into extensive use in recent years in the United States, for both railways and highways, is the vertical-lift bridge, in which the movable span travels vertically between tall towers while retaining its horizontal position. This span is suspended by means of cables hanging over sheaves or pulleys at the tops of the towers, the cables having one end fastened to the span and the other end to a counterweight moving in the tower. What is believed to be the largest movable span in existence is of this type, being the 534ft. lift span in the highway bridge across the Delaware River at Burlington. This important structure, with its lift span in the raised position, is shown in Fig. 1. The vertical-lift principle is old, but its extensive application to large modern structures is a notable development in American bridge engineering.

In other countries this type of drawbridge has been adopted only to a very limited extent for modern bridges. The idea originated apparently in connection with the design of bridges crossing canals at a low level and requiring some means of lifting them to permit the passage of boats. Both the length of span and height of lift were small in such cases.

An early example in England was a single-track bridge built by Mr. Jacomb Hood to carry a line of the London, Brighton and South Coast Railway across the Surrey Canal. This was a deck plate girder structure of 22ft. 6in. span, with a vertical travel of 10ft., and was operated by two men at hand winches. In 1909 a plate girder lift span of 27ft. 9in. was built to give a passage through a concrete jetty in the harbour for submarines at Haslar. The first large bridge of the lift type in Great Britain is the one over the Tees at Middlesbrough, which is to be opened to traffic shortly. It is a highway bridge, with a length of 250ft., having a roadway 38ft. wide and two cantilevered footpaths, each 9ft. wide. It will give a clear headroom of 30ft. when lowered and 120ft. when raised. This 250ft. lift span is flanked on each side by five approach spans, the total length of the bridge being 4920ft. The consulting engineers are Messrs. Mott, Hay and Anderson, and Dorman, Long and Co. are the contractors for the steel superstructure. Several small bridges of this type, crossing canals, have been built in France.

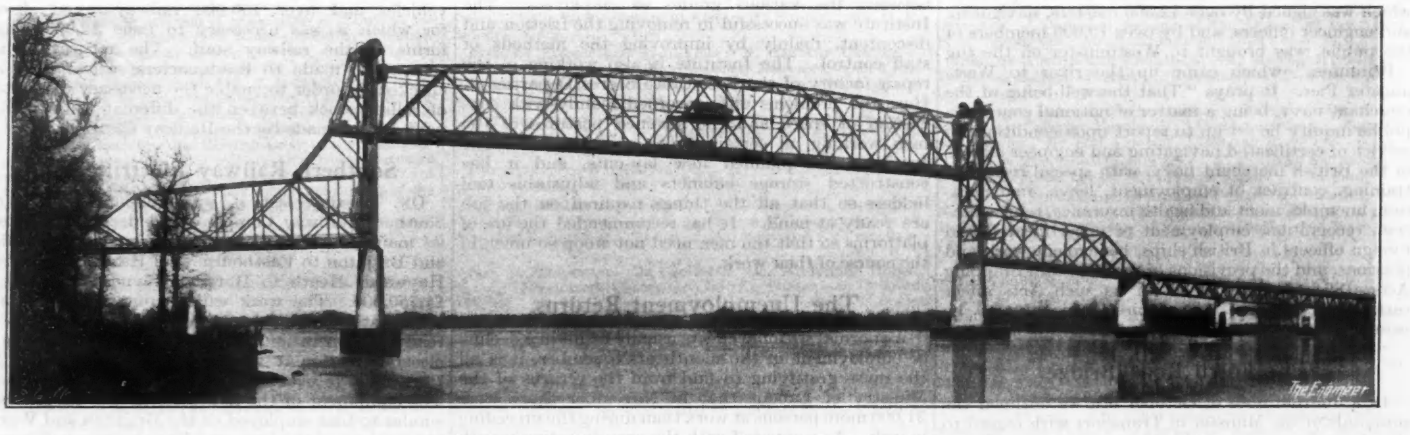


FIG. 1—LIFT SPAN OF THE DELAWARE RIVER BRIDGE

In America, between 1870 and 1880, a number of such bridges were built over the Erie Canal by Mr. Squire Whipple. In these structures, however, the towers carried a fixed overhead truss span and the lifting deck had hanger rods which telescoped in the posts of the trusses and were attached to counterweighted cables. This arrangement has been applied in recent years to double-deck bridges, having the decks operated independently, as will be noted later.

A Typical Lift Bridge.

A typical design of a vertical-lift bridge is given in Fig. 2. This drawing represents two recent duplicate bridges on a public highway, which crosses the Hudson River at Albany, and again at Troy, a few miles further upstream. The clearance above water is 35ft. 6in. with the span lowered and 135ft. with the span raised. Although not the longest, these are by far the heaviest bridges of this type, for with a length of 341ft. between end bearings, the weight in each case is 2730 tons, exclusive of counterweights. This weight includes 1360 tons of structural steel, 1110 tons for the concrete paving, and 260 tons for the machinery, cables, electric equipment and petrol engine as a stand-by unit. The deck or floor provides a roadway, 42ft. wide between kerbs, and two 6ft. walks outside the trusses, all paved with concrete. The roadway is designed to carry 20-ton motor trucks.

Cables attached to the ends of the bridge pass over sheaves on the towers and down to the two counterweights, which together equal the total weight of the lift span. There are ninety-six cables, 2⅜in. in diameter, the forty-eight at each end being divided into six groups of eight cables, each group having its own grooved sheave on the tower. This grouping of the cables is shown by the cross section in Fig. 2. Variable voltage control is used for the two main motors of 250 H.P., requiring the use of a motor generator set. The machinery, mounted in a house on the lift span, drives two drums on each side of the bridge, from which the operating cables lead to guide sheaves at the ends of the span. Thence they divide, a set of up-haul cables extending to the top of the tower, and another set of down-haul cables extending to the foot of the tower. Current for the motors is taken from power cables suspended between the towers and upon which ride collectors mounted on a triangular steel frame pivoted on top of the machinery house.

The system of operation described above is used on a majority of the vertical-lift bridges, but other systems are in use and will be dealt with later.

Examples of Lift Bridges.

Four typical bridges of the vertical lift type are shown in Figs. 5 to 8. The Suisun Bay bridge of the Southern Pacific Railway (Fig. 5, page 572) has a 328ft. double track lift span of about 1680 tons weight, with a vertical travel of 65ft., increasing the headroom from 70ft. to 135ft. This lift is made in 90 seconds by two electric motors of 150 H.P. In the Illinois River highway bridge at Hardin (Fig. 6) there is a lift span of 309ft. length, with a lift of 57ft., giving a clearance of 8ft. when lowered and 65ft. when raised. In the James River bridge (Fig. 7), also a highway structure, the 300ft., 470-ton lift span has a vertical travel of 95ft., increasing the normal clearance of 53ft. to a maximum of 148ft. The lift span of the 7-mile highway bridge across San Francisco Bay, at San Mateo (Fig. 8), has a length of 298ft., and a vertical travel of 100ft. Its weight is 665 tons, including 43 tons of operating machinery. The view shows the span being floated into position between the towers. The footpath above the trusses gives access to the guide sheaves which support the operating cables leading from the machinery house to the end of the span.

American Vertical-Lift Drawbridges.

River or bay.	Place.	Railroad or highway.	Length.	Weight.
			Feet.	Tons.
Delaware River	Burlington	Highway	534	1240
Missouri River	Boonville	M., K. and T. R.R.*	408	1150
Hudson River	Albany	Highway	341	2750
Hudson River	Troy	Highway	341	2750
Hackensack River	Jersey City	Pennsylvania R.R.†	331½	1800
Hackensack River	Jersey City	Pennsylvania R.R.†	206	—
Hackensack River	Jersey City	Highway	206	—
Suisun Bay	Near San Francisco	Southern Pacific Ry.†	328	1680
Newark Bay	Newark	Pennsylvania R.R. and Lehigh Valley R.R.†	322	1805
Illinois River	Hardin	Highway	309	556
Des Plaines River	Joliet	Chicago, R.I. and Pacific Ry.†	302	1235
James River	Newport News	Highway	300	470
San Francisco Bay	San Mateo	Highway	298	665
Chicago River	Chicago	Pennsylvania R.R.‡	273	1500
Calumet River	Chicago	Pennsylvania R.R.‡	210	—
Calumet River	Chicago	New York Central R.R.§	210	—
Hackensack River	Jersey City	Del., Lack. and Western R.R.‖	198	1200
White River	De Vall's Bluff	Chicago, R.I. and Pacific Ry.*	182½	361

* Single track. † Double track. ‡ Two double-track bridges side by side. § Four tracks. ‖ Three tracks.

Although the first large bridge of this type was opened at Chicago in 1894, it was not followed by another for some years, and it is within the past decade that such bridges have been built in large numbers. Some of the larger of these structures are listed in the accompanying table. The longest span, 534ft., is in the Delaware River highway bridge already mentioned. The longest railway lift bridge is the 408ft. span in the bridge carrying the Missouri, Kansas and Texas Railroad across the Missouri River near Boonville. Next to it in length come the 341ft. lift spans in the two highway bridges over the Hudson River, the 331½ft. lift span of the Pennsylvania Railroad bridge over the Hackensack River at Jersey City, and the 322ft. lift span in the long bridge carrying the Pennsylvania Railroad and the Lehigh Valley Railroad across Newark Bay, near New York.

An unusual feature of the Hackensack River crossing is the fact that the Pennsylvania Railroad has two parallel bridges—one, with the 331½ft. lift span, for the passenger lines, and the other, with a 206ft. lift span, for the freight or goods lines; while close at hand is a highway bridge with a 206ft. lift span. Of the bridges over the Calumet River, with 210ft. lift spans, the New York Central Railroad has a single bridge carrying four lines of rails, while the Pennsylvania Railroad has two double-track bridges side by side. This railway uses the same arrangement for the two 273ft. lift spans on its four-track line over the Chicago River. The heaviest lift spans are two of 341ft. span in duplicate bridges crossing the Hudson River at Albany and Troy, weighing 2730 tons each.

From such large bridges the lift spans range in length downward to an 82ft., 30-ton, through-truss span on a country road, and a 50ft. plate girder deck span carrying a railway across a drainage canal. Both of these spans are equipped only with hand-power operating mechanism, as they are opened at very infrequent intervals. In fact, the lifting girder span is provided simply to permit the passage of dredges used occasionally in cleaning the canal.

Advantages of Lift Bridges.

Vertical-lift bridges, like bascule bridges, give a clear channel, unobstructed by a pivot pier, as usually required for swing bridges. By moving in a vertical direction—also like bascule bridges—they avoid interference with adjacent shore property, while with swing bridges a certain amount of water front is rendered useless by the necessity of keeping a clear space for the swinging of the span. The operating time of a lift span is about one-third that of a swing span, and is less subject to difficulty or delay by high winds. There is also less strain in the moving structure of a lift span than in a swing or bascule span, so that the design of the lift span is much simpler. In fact, there is little difference between a lift span and a fixed span of the same weight, except that a top cross girder is required at each end for the cable attachments. One long bridge over a river with a shifting channel is so designed that the towers and lift span can be transferred to the position of one of the present fixed spans, if that should become necessary. The comparative cost of the different types of drawbridges can be determined only for each individual enterprise, since the cost depends so much upon local conditions.

It has been pointed out by Mr. O. E. Hovey, consulting engineer, in a paper before the American Society of Civil Engineers, that vertical-lift spans have no positive reactions from dead load at either end when closed, and end locks are required to prevent vertical play under traffic. He says: "When the span is raised the centre of wind pressure is higher than for bascules and general stability must be provided to meet this condition. This may make it necessary to increase the width of the bridge and the size of the piers and foundations. The counterweights weigh the same as the span, thus being much lighter than those for bascule bridges of the same length. The counterweights are usually attached to the ends of the span by wire ropes extending up and over large sheaves, which turn on trunnions on top of the towers. In some designs articulated links (connected to rocking levers) are used for this purpose. In either case, however, the mechanical parts are always under stress and must be carefully maintained. Moreover, repairs and renewals are difficult and expensive."

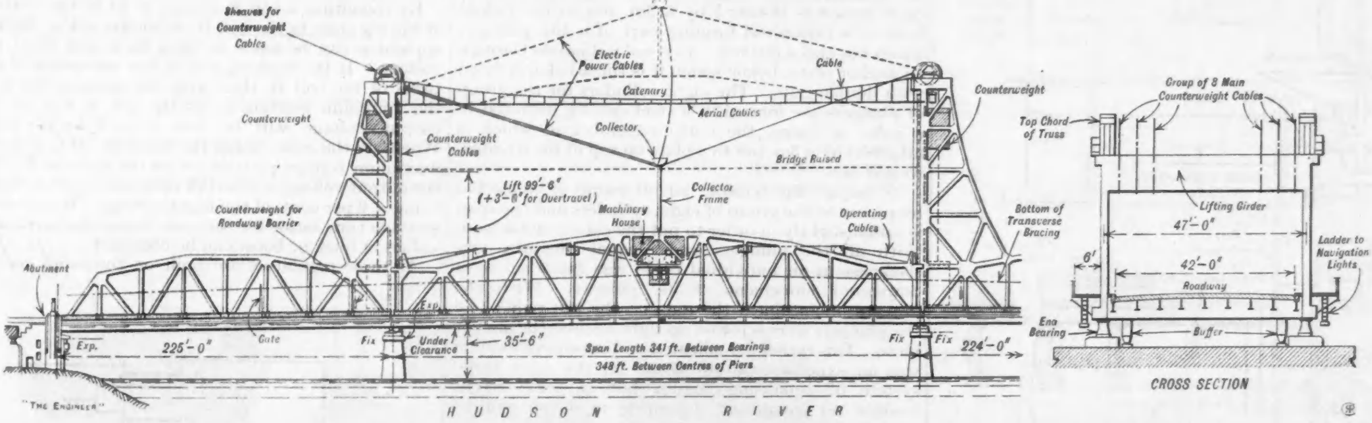


FIG. 2—DESIGN OF TWO VERTICAL-LIFT DRAWBRIDGES ACROSS THE HUDSON RIVER AT ALBANY AND TROY

"Where the waterway is wide, the length of the fixed spans is greater than would be required with swing spans. Also, the operating machinery must accelerate a greater mass than in a swing span, but less than in a bascule. However, the resistance from wind pressure is small, and the power required is intermediate between swing spans and trunnion bascules. A vertical-lift bridge is less expensive than a bascule, the cost being intermediate between that for swing spans and bascules."

DESIGN OF VERTICAL-LIFT BRIDGES.

Special provisions for the design of vertical-lift bridges are included in the standard specifications for movable bridges, as adopted by the American Railway Engineering Association. These provisions include formulæ for the strength of wire cables that are bent by passing over sheaves. The total unit tension in the counterweight ropes is not to exceed one-fifth of the specified unit ultimate strength of the rope, and the unit tension from the direct load is not to exceed one-tenth of that ultimate strength. For the operating ropes these limits are one-third and one-sixth of the ultimate strength. The weight of the counterweight cables must be balanced by chains hung beneath the counterweights. Unless otherwise specified, these balancing chains are to consist of cast iron links connected by steel pins in cored holes in the links. Wind pressure is to be assumed as 15 lb. per square foot on the exposed surface of the floor and the two trusses.

The diameters of cable sheaves are to be not less than seventy-five times the diameter of counterweight cables or forty-five times for operating cables, but ninety and fifty times the diameter, respectively, are considered preferable. Counterweights must be so divided into parts that no part is hung from more than sixteen cables, the cables of each group being attached to its part of the counterweight by an equaliser. However, in many recent bridges this use of equalisers has been eliminated by having all cables cut to length while under stress, as noted more fully later.

All cables are specified to be of improved plough steel and to consist of six strands of nineteen wires each, laid around a hemp centre. Their diameters are to be not less than 1in. nor more than 2½in. for counterweight ropes, and not less than ¾in. for operating ropes. The operating ropes are to have at least two full turns on the drum when the span is in its full open or full closed position, and it is recommended that the number of turns should be sufficient to develop the ultimate strength of the rope by friction, the coefficient of friction being taken as 0·20. A turnbuckle, clevis, or other device must be provided for taking up slack in the rope. In counterweight ropes the deviation from the vertical should be as small as possible, the deviation from the plane through the centre of the groove in the sheave not exceeding 1 in 40. These separate requirements for operating cables and counterweight cables are ineffective in the latest designs of vertical-lift bridges, in which the counterweight cables serve also as operating cables, as described later in this article.

HALSTED-STREET LIFT BRIDGE, CHICAGO.

The first important modern bridge of the vertical lift type was the Halsted-street Bridge at Chicago, over the Chicago River, which was opened in 1894, replacing a swing bridge that had been damaged by a steamer. The lift span was of the through-truss type, 138ft. long, giving a clear waterway opening of 130ft.; it had a 36ft. roadway and two 7ft. sidewalks outside the trusses. The clearance above water level was 14½ft., with the bridge closed, and 155ft. with the bridge raised to its full height. The two pairs of steel towers were about 217ft. high above the water line and had the very unusual feature of being connected at their tops by truss struts, in order to prevent any inward deflection or inclination under the load of the span in its suspended position. This overhead connection, which served also to carry idler sheaves for the operating cables, is used only in very few such bridges. It has been included in some short canal bridges, and in a 214ft. highway span at Tacoma it was adopted in order to carry a water main across the channel.

Separate groups of cables were used for the counterweighting and the operating functions. At each end of the span were eight 1½in. cables, doubled or looped and hung over the sheaves on the tower, both ends of the cable being attached to the span, while the loop or bight hung in the tower. From 15in. equalising sheaves riding in the bights of the cables the counterweight was suspended. In this way there were sixteen counterweight cables attached to each end of the lift span and passing over pulleys 12ft. in diameter on the towers. The weight of these cables was balanced by chains attached to the bottom of the counterweight and the bottom of the lift span. The total weight of the span was nearly 300 tons, and as this was almost exactly balanced by the counterweights, the operating machinery had only to overcome the slight excess of dead load, the friction, and the varying dead load of dirt and snow. This machinery was designed, however, to lift a 1-ton excess load.

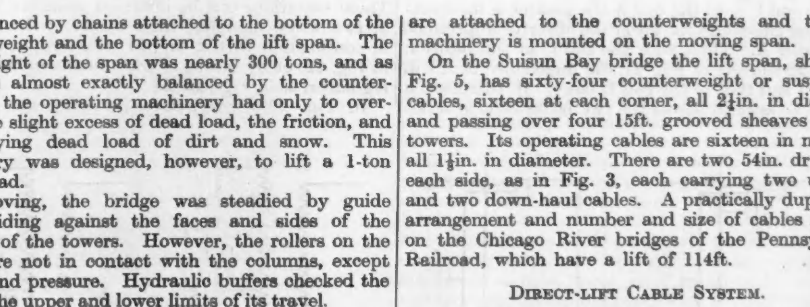


FIG. 3—ARRANGEMENT OF COUNTERWEIGHT AND UP-HAUL AND DOWN-HAUL CABLES

In moving, the bridge was steadied by guide rollers riding against the faces and sides of the columns of the towers. However, the rollers on the sides were not in contact with the columns, except under wind pressure. Hydraulic buffers checked the span at the upper and lower limits of its travel.

A steam hoisting plant was built under the north approach, two vertical inverted engines driving a shaft having two 6ft. spirally grooved drums, on each of which were eight ⅞in. operating cables. Electric motors replaced the steam engines in 1907. These cables passed under 6ft. guide sheaves at the bottom of the tower and over similar sheaves at the top of the tower. Four of the cables then led down to an attachment on the north end of the span; the other four were led across the top strut to the opposite tower, and then down to an attachment on the south end of the span. From the second drum, eight cables led up to the top of the north tower and four of them passed down to be attached to the counterweight in this tower. The other four continued across the top strut and down to the counterweight in the south tower. In this way the span was raised by direct pull and was lowered by pulling up the counterweights.

This Halsted-street lift bridge was replaced in 1931–32 by a bascule bridge, as its width and strength were not adequate for present-day traffic and vehicle loads. Although some of the counterweight cables had been in use for twenty-eight years, they were in good condition, except at the attachments to the lift span, which were of a type now obsolete.

CABLE SYSTEMS.

Until about six years ago three independent sets of cables were used at each end of these lift bridges—(*a*) the suspension cables attached to the sheaves and the counterweights; (*b*) and (*c*) the up-haul and down-haul operating cables wound upon driving drums, usually mounted in a machinery house built on the lift span. Equalising devices were provided at the attachments of the counterweight or suspension cables in order to maintain a uniform tension in the several individual cables. The operating cables passed over guide sheaves on top of the span to end sheaves, where they diverged. The hoisting or up-haul cables (*b*) passed under the end sheave and up vertically to attachments at the tops of the towers; the lowering or down-haul cables (*c*) passed over the end sheaves and down to similar attachments at the bottoms of the towers. The attachments were long-threaded eye-bolts, permitting adjustment of the length of the cable. This cable arrangement is illustrated by the diagram Fig. 3, and it will be seen that the span was positively pulled up or down according to the direction of rotation of the drums. It differs from that of the Halsted-street bridge in that no operating cables are attached to the counterweights and that all machinery is mounted on the moving span.

On the Suisun Bay bridge the lift span, shown in Fig. 5, has sixty-four counterweight or suspension cables, sixteen at each corner, all 2¼in. in diameter, and passing over four 15ft. grooved sheaves on the towers. Its operating cables are sixteen in number, all 1⅛in. in diameter. There are two 54in. drums on each side, as in Fig. 3, each carrying two up-haul and two down-haul cables. A practically duplicated arrangement and number and size of cables is used on the Chicago River bridges of the Pennsylvania Railroad, which have a lift of 114ft.

DIRECT-LIFT CABLE SYSTEM.

A radical departure from this arrangement of using three separate groups of cables was the utilisation of the counterweight cables to serve also as operating cables by the seemingly simple process of applying power to the big sheaves on top of the towers. This greatly simplifies the cable system and relieves the lift span of the weight of operating machinery. In one large lift bridge having the older arrangement, the total weight of the lift span was about 1800 tons, of which about 125 tons was for the machinery, cables, and machinery house. The newer system was used first on the White River bridge, built in 1927, by the Chicago, Rock Island, and Pacific Railway.

The White River bridge, at De Valls' Bluff, is a single-track structure having a through-truss lift span of 182ft., with two flanking spans of 150ft., in which are incorporated the 100ft. towers carrying the cable sheaves. At each end of the lift span is a transverse portal girder or lifting girder to which the cables are attached. In addition to the novel direct-lift system, this bridge is notable for a hydraulic equaliser system in the cable attachments.

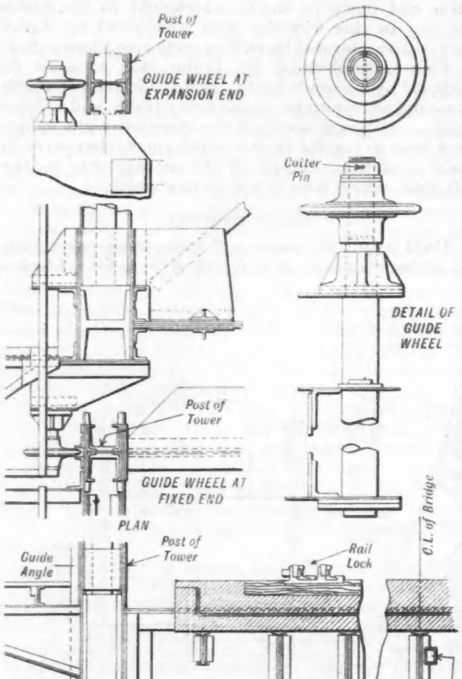


FIG. 4—GUIDE WHEEL ARRANGEMENT

At each corner of the White River lift span eight 1⅝in. cables are attached in fan shape to the lifting girder, which has connection plates with holes for 3in. pins, which pass through the forked ends of the cable sockets. The eight cables are brought together by a clamp about 6ft. above the girder, continuing then vertically to the grooved sheave on top of the tower and hanging down for attachment to the counterweight box, which moves in guides in the tower. These sheaves are 5ft. 6in. in diameter, grooved for the eight cables and shrouded on each side. On the inward face of the sheave is bolted a circular rack. At the top of the tower, two pairs of 25 H.P. electric motors drive through trains of spur and bevel gears to a single horizontal shaft, which carries at each end a pinion gearing with the circular rack on the cable sheave.

The hydraulic equalising device, already mentioned, forms the connection between the cables and the counterweight box. Here the flat tail of each cable socket is fastened by a 3in. pin to the forked head of a piston-rod forming part of a 4in. plunger, which has also a tail rod. This tail rod passes through an anchor plate, below which it is threaded and fitted with double nuts. The eight cylinders for the group of plungers are formed in a steel casting mounted in a yoke or frame, the bottom member of which is attached by a 3in. pin to a plate on top of the counterweight box.

To adjust the tension, an oil pump is connected by piping to the group of eight cylinders and the span is raised slightly in order to put the cables under load. With all the plungers under equal pressure, any slackness in an individual cable was taken up by a downward movement of its plunger. With the pressure maintained, the nuts on the tail rods of all the plungers were screwed up tight against the anchor plate. This rather complicated and expensive method was an experimental substitute for the more usual system of equalising beams, but in some recent bridges no equalising system is used, as will be explained later.

BRIDGE GUIDES.

To steady the bridge when moving, and to provide a bearing against wind pressure, four guide wheels at the corners of the lift span ride against the outer side faces of the main posts of the towers. In the guide wheel arrangement of the Des Plaines River railway bridge, shown in Fig. 4, a 26in. wheel with 1½in. rim is carried in an extension of the bottom chord at each corner of the span. At the fixed end of the span, the two wheels ride in grooves formed by two angle irons, 4in. by 4in., riveted to the sides of the tower posts. At the expansion end there are no grooves, the wheels riding upon the posts. Normally, these wheels stand ⅜in. away from actual contact.

(To be continued.)

A.C. Voltage Regulators.

No. III.

(Continued from page 542, December 1st.)

THE Ferranti patented moving coil regulator was described briefly in our issue of February 19th, 1932, but it cannot be neglected in this series of articles. It comprises, as shown in Fig. 21, a two-legged core with coils A and B and a short-circuited coil C free to move up and down the leg between the coils A and B. As the moving coil C is entirely isolated, no flexible connections or slip rings are required. Assuming that a voltage is applied to the coil A only, the resulting current in the coil will, of course, be dependent on its impedance, which is determined by the position of the coil C, for this coil may be regarded as a gate serving to prevent the passage of magnetic flux through it. The closer the moving coil C is to the coil A the greater is its short-circuiting effect and the lower the effective impedance of the coil A. Thus, with the coil C in the position shown on the left of Fig. 21, the impedance of A will be small and that of the coil B large. If, therefore, a voltage be applied across the two latter coils in series the greater part of the voltage will appear across B and only a small part across the coil A, as indicated on the left of Fig. 21. But with the moving coil at the bottom of the leg, as shown on the right of this illustration, the greater part of the voltage will exist across the coil A. Under the conditions assumed in this particular case, and with an impedance variation of 20/1, the voltage across the coil B can be varied smoothly and uniformly from 5–95 volts by moving the coil C in the manner described. Only under exceptional conditions, however, such, for example, in testing transformers, is such a wide voltage variation necessary, a variation of 10 to 20 per cent. being sufficient on transmission and distribution circuits. These variations can be obtained from the regulator in two ways, namely, either by using the regulator in conjunction with a tapped transformer, as shown in Fig. 22, or by means of additional windings on the regulator, as in Figs. 23–25.

In Fig. 22 the regulator is connected across a portion of the transformer winding and by choosing suitable tappings any desired range of voltage variation can be obtained, the typical range indicated in Fig. 22 being 91–109. The second method, however, lends itself to more general application, as the regulator works without a transformer or other apparatus. In effect the voltage variation obtained in accordance with the method shown in Fig. 21 is stepped down to the desired value by means of an additional coil or coils connected in series with the line. The scheme giving boost only is shown in Fig. 23 and diagrammatically in Fig. 24, in which the voltage across the coil D will be a constant fraction of the voltage across the adjacent coil A, depending upon the turn ratio of the two coils. In the diagram Fig. 24 it is assumed that the coil A has ten times the number of turns D, and from the values marked on the diagram it will be seen that the output voltage varies from 100·5 in the minimum voltage position to 109·5 in the maximum voltage position. By reversing the coil D its voltage would be subtracted from the input voltage instead of added to it, and the secondary pressure would then vary from 99·5 to 90·5 volts.

By mounting a coil E similar to D at the bottom of the leg close to the coil B, as shown in Fig. 25, the apparatus can be made to both buck and boost the voltage. If the bucking coil E has one-tenth of the turns of the coil B, then with the moving coil C in the minimum position as on the left of Fig. 25 the output voltage will be $100+0\cdot5-9\cdot5=91$ volts. When, on the other hand, the moving coil C is in the maximum voltage position, as on the right of Fig. 25, the output voltage will be 109 volts, the total variation being ±9 per cent. of the input voltage. By selecting suitable turn ratios for the coils D and E any desired values of buck or boost can be obtained.

As these regulators are built on the same lines as static transformers, they can be designed for high voltages and heavy currents and they do not necessitate the use of series and shunt transformers. The smallest regulators for indoor operation may be air insulated and air cooled, but all others are oil immersed in plain, tubular or radiator tanks depending upon the capacity. Single-phase regulators have a core with three legs, the centre leg being wound and, in the case of small regulators, the moving coil is carried on a non-magnetic frame and is operated by a square-threaded shaft. A disc induction motor, as described in connection with the Ferranti mercury switch "on load" tap-changing gear provides the drive for automatic operation.

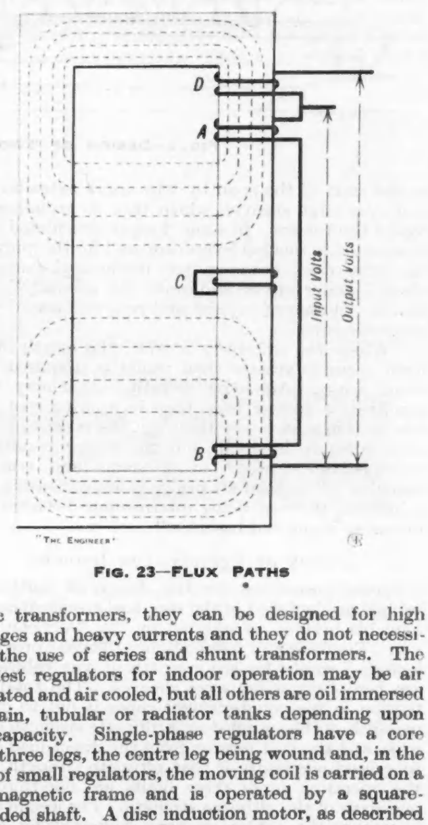


FIG. 23—FLUX PATHS

On larger size regulators the moving coil is supported at both ends, and is operated by two square-threaded vertical shafts, as shown in Fig. 26. The disc induction motor operates the moving coil through skew and worm gears, but on the largest regulators ordinary three-phase induction motors are employed. Three-phase regulators have rectangular cores, with three wound legs and the moving coils of each phase are held in a common framework operated by two square-threaded vertical shafts at either end of the core. As will be gathered from Fig. 27, the disc induction motor is mounted on the top of the core and drives a horizontal shaft which operates the square-threaded vertical shaft through worm and bevel gears. Except in the case of the largest regulators, all the mechanical operating gear, including the motor, is oil immersed. Complete with its mechanical gear, as a unit, the regulator is contained in a transformer tank, as illustrated in Fig. 28, which shows a fully automatic 20-kVA single-phase regulator for use on a 230-volt circuit and for giving a 10 per cent. boost. Regulators of all sizes can be designed for outdoor operation and are provided when necessary with cable boxes or hangers for pole mounting and a feeder pillar type of regulator is also made.

In order to reduce the current in the short-circuited winding, the coils A and B are connected in opposition,

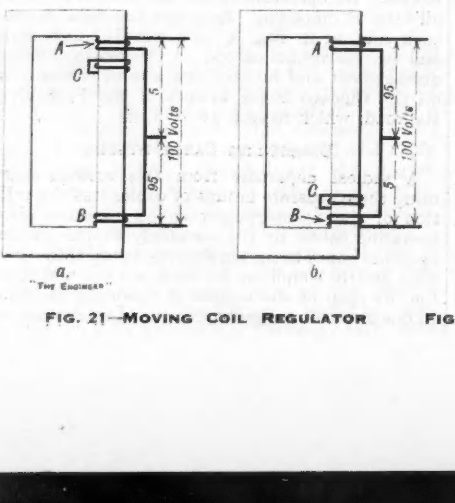


FIG. 21—MOVING COIL REGULATOR

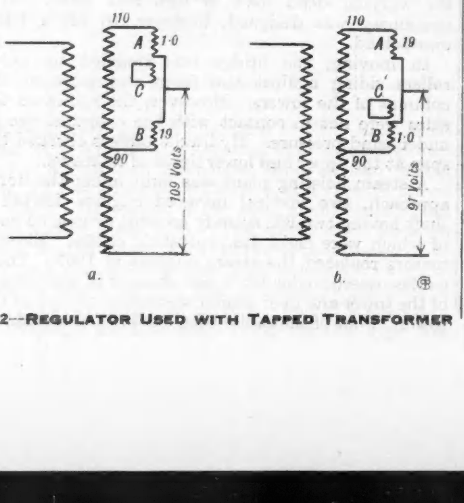
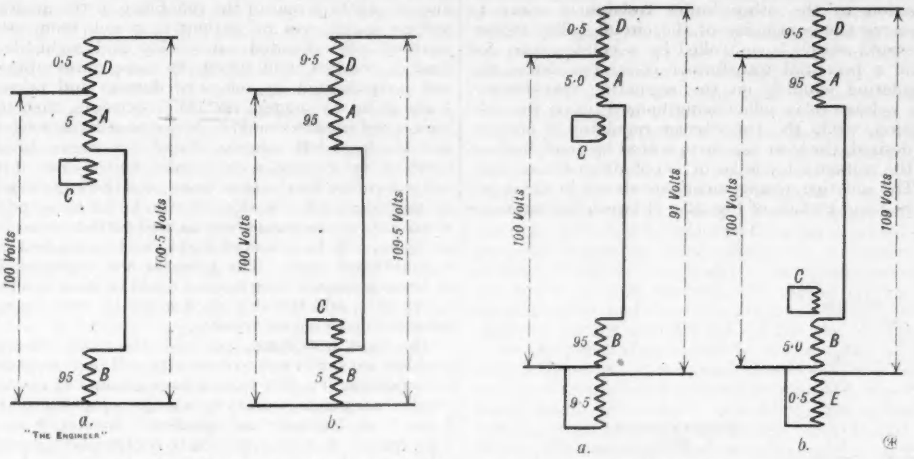


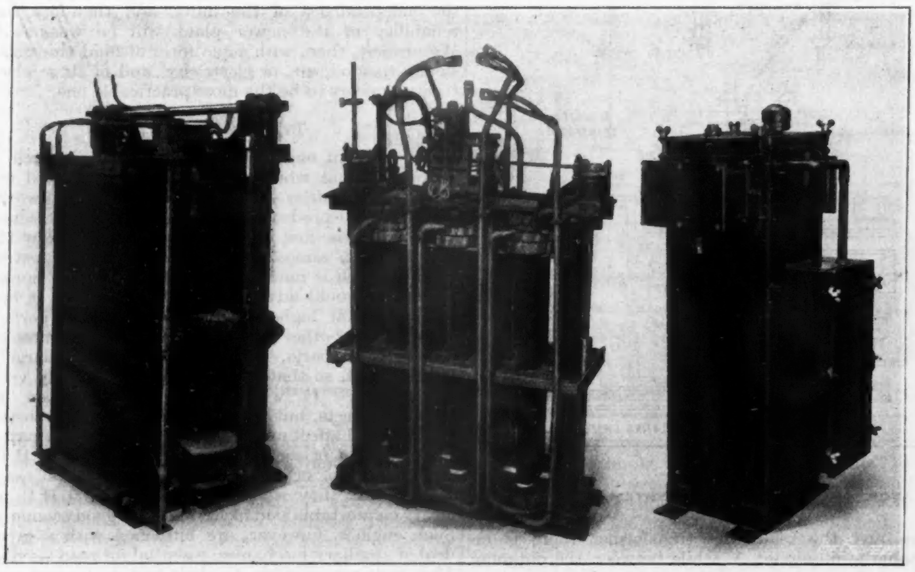
FIG. 22—REGULATOR USED WITH TAPPED TRANSFORMER

and for any position of the regulator there is no current in the short-circuited coil at no load. Under load conditions the current is proportional to the load current, but still independent of the regulator position.



FIGS. 24 AND 25—REGULATORS WITH ADDITIONAL WINDINGS

Losses on load and at no load vary with the current and flux densities and weights of iron and copper, and can therefore be varied in accordance with cost, as in any ordinary transformer. With a constant primary voltage the no-load current is practically constant for all positions of the regulator, and owing to the low flux density and large proportion of air path in the magnetic circuit, the magnetising current is said to be practically sinusoidal. Thus all troubles, such as telephone interference, condenser breakdowns, &c., are avoided. It is said that in standard regulators the maximum force on the moving coil in the worst position at full load is less than the weight of the coil itself, and the power required to move the coil is therefore very small. Thus for all except the largest regulators a disc type induction motor is sufficiently powerful.



FIGS. 26 TO 28—SINGLE AND THREE-PHASE FERRANTI MOVING COIL REGULATORS

On full load a regulator giving 10 per cent. voltage range the ratios of input to output kVA with load powers factor of 1, 0·95 and 0·85 are said to be 1·0025, 1·022 and 1·038 respectively with the regulator in the maximum voltage position. The makers point out that these figures are equivalent to those of an ordinary transformer having a magnetising current and impedance of 3½ per cent. in each case, and that it is easy to reduce them by reducing the reactance. With the values chosen, however, the regulators are claimed to withstand dead short circuits with infinite power behind them. The moving coil regulator is free from the phase displacement produced by a single polyphase induction regulator. Other advantages claimed are silent operation and simple control.

Owing to saturation of the iron under short-circuit conditions, the forces on the moving coil do not increase as the square of the load current. Nine circuits on a regulator with the moving coil in various positions are said to have no detrimental effects on the apparatus. A 5-kVA regulator, giving ±10 per cent. voltage variation on a 460/320-volt circuit, was connected on the primary side through a large step-down transformer to 6000-volt mains, and the power was such that the short circuit caused negligible voltage drop. Full primary pressure was therefore maintained on the regulator under short-circuit conditions, and short-circuit currents ranging from 10 to 19·5 times the full load value were obtained. Nevertheless, the short-circuit had no ill-effects on the apparatus. Provided simultaneous operation is ensured by coupling regulators mechanically, or, alternatively, by electrical control, they can be worked in parallel, but the regulators must, of course, have appropriate internal impedance valves in the same way as when ordinary transformers are connected in parallel. When regulated feeders are to be operated in parallel with unregulated feeders, the effect of feeder impedances and regulation on circulating currents and load distribution, as well as voltage, must be considered, and in special cases of parallel operation for tie lines or interconnection purposes, short-circuited compensating coils can be provided to give negligible impedances or controlled values over the regulator range.

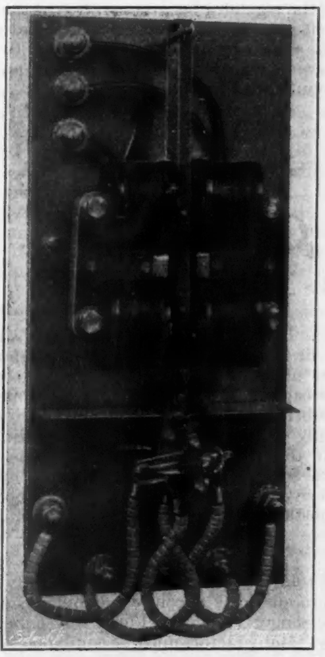


FIG. 29—MERCURY SWITCH CONTACTOR

The control panel is the same as that used for the mercury switch on-load tap-changing gear, described in the previous article and illustrated in Fig. 18. Similarly, the same type of motor is used for all Ferranti moving coil regulators, except the largest, and it is scarcely necessary to describe the control system here. The voltage relay associated with the control panel illustrated in Fig. 18 in the previous article operates directly on two small mercury switches in the motor circuit, and are controlled by two simple solenoids, as shown in Fig. 29.

TRANSFORMER BOOSTER REGULATOR.

The type of booster regulator shown in Figs. 30 and 31 has been made by the British Electric Transformer Company, of Hayes, Middlesex, for a considerable time. A regulating or auto-transformer is used to excite a second transformer, the secondary windings of which are connected in the lines to be regulated. It can be used in any existing circuit and, although the equipment is suitable for high voltages, the switchgear generally operates in a low-pressure circuit. Another advantage claimed is that the apparatus is self-contained and can easily be isolated from the controlled circuit by a simple arrangement of isolating switches. Fifty-eight of these regulators have recently been constructed for an overseas municipality for use on the distributors of a 400-volt three-phase 50-cycle four-wire system. They are designed to give ±10 per cent. regulation in 1 per cent. steps and for currents ranging from 250-1500 ampères, two sets being installed in each sub-station. The regulators are automatically controlled. At no load they keep the pressure at each sub-station constant and increase it somewhat as the load grows. One of the regulators is shown in Fig. 31. The switchgear is contained in a casing attached to one side of the tank which contains the regulating and series transformers. The main face plate regulating switch is an elaborate form of old-fashioned battery switch, but the face plate contacts are relieved of sparking by contactors in both the main and pilot brush circuits. A motor which derives its supply from the regulator serves for operating the switch, and the necessary maintaining switches, starting and stopping contactors are fitted on the panel adjacent to the switch. In the case of emergency the regulator may be operated manually by means of a handle, but normally a switch on the casing with "off," "raise," "lower," and "automatic" positions serves for hand operation. Relays required for automatically controlling each pair of regulators are separately housed in a light sheet steel casing and comprise voltage, time delay, and paralleling relays. There are also three rheostats for voltage setting and resistance and reactance drop compounding and various interlocking relays. The paralleling relay is connected between two potential transformers, which ensure that two regulators working in parallel remain in step.

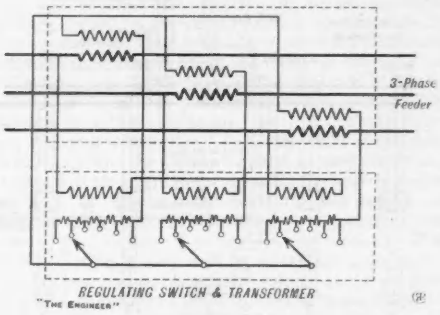


FIG. 30—BOOSTER CONNECTIONS

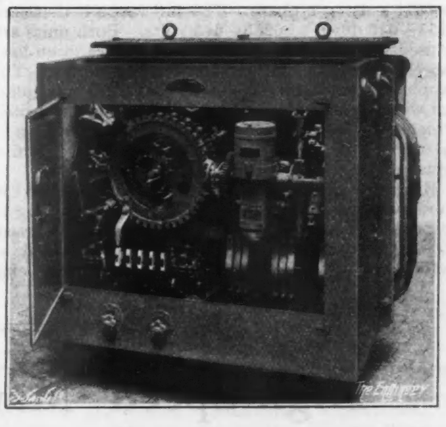


FIG. 31—BRITISH ELECTRIC TRANSFORMER REGULATOR

An example of the use of a transformer booster regulator in connection with a bulk supply is shown in Fig. 32. The voltage at a grid sub-station varied between the limits of 5610 and 6900, and it was therefore decided to install a feeder regulator to maintain a constant pressure of 6600 volts at the bus-bars of the supply undertaking's sub-station. Low initial cost, low running losses and noiseless operation are said to have been the factors which led to the choice of a transformer booster. Silent operation was very essential, as the regulator has had to be installed near a church. Another requirement was that the regulator should be capable of being put into or taken out of circuit without interrupting the supply. The equipment consists of the following apparatus :—(1) A regulating transformer designed for 6600/6255 volts auto-connected with a secondary winding for 341 volts per phase, divided into five equal sections ; (2) a series transformer designed for 645 volts between lines and insulated for 6600 volts with a secondary for 341 volts per phase. The full range is therefore 6255+645 down to 6255−645 volts. Both units are housed in a common tubular tank with the on-load tap-changing mechanism mounted on one side. The tappings from each of the five sections of the regulating winding are brought to the contacts of the switch which allows the voltage of the regulating winding to be applied to the series secondary winding in five equal steps.

By means of a change-over switch incorporated in the mechanism the polarity of the series winding in respect of the regulating winding can be reversed, so that the same regulation can be obtained as before, but in the reverse direction, the result being that the full variation is obtained in ten equal steps. As the actual circuit breaking takes place on auxiliary contacts, there is no arcing on the brushes or contacts of the selector switch. When changing from one position to the other buffer resistances serve to preserve the continuity of the circuit. The motor-operated switch is controlled by a voltage relay fed from a potential transformer connected across the regulating winding on the regulating transformer, the voltage relay pillar being housed inside the sub-station, while the transformer regulator is outside. If desired, the gear can be operated by push buttons in the voltage relay pillar in lieu of automatic control.

The isolating arrangements are shown in the upper right-hand portion of Fig. 32. Between the incoming lines and the regulating transformer there is an automatic oil circuit A, while between the outgoing side of the regulator and the outgoing bus-bars there is a non-automatic circuit breaker B. Between the incoming and outgoing bus-bars there is a three-phase air break isolator C, all these switches being contained in an outdoor switch kiosk. With the switch C closed and the regulator switch in the no-boost position the regulator is put into service by closing the circuit breakers A and B, when on opening the isolator C the regulator begins operation as the voltage relay is put into circuit. To take the regulator out of service the regulator switch is first moved to the no-boost position, isolator C is then closed, and afterwards circuit breakers B and A are opened.

(To be continued.)

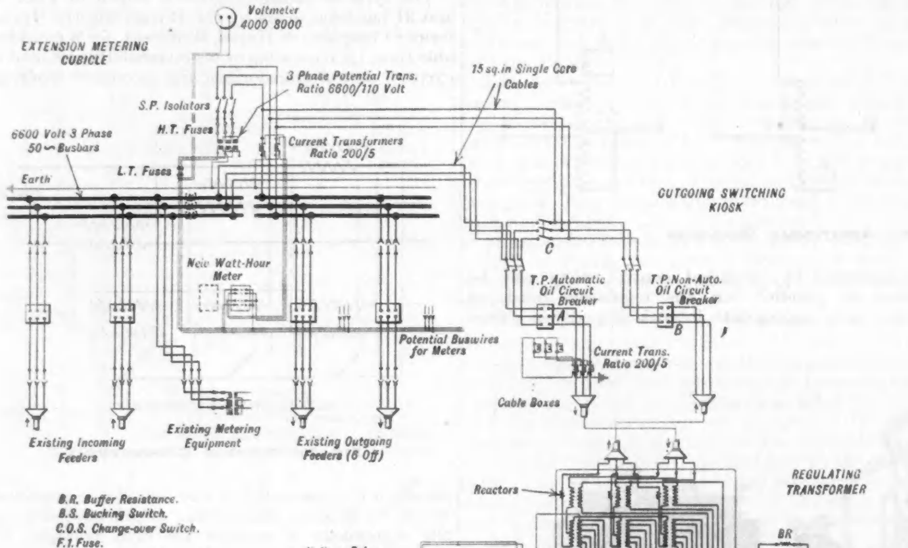

Voltmeter 4000 8000
EXTENSION METERING CUBICLE
3 Phase Potential Trans. Ratio 6600/110 Volt
15 sq.in Single Core Cables
S.P. Isolators
H.T. Fuses
6600 Volt 3 Phase 50 ~ Busbars
Current Transformers Ratio 200/5
L.T. Fuses
Earth
OUTGOING SWITCHING KIOSK
C
New Watt-Hour Meter
T.P. Automatic Oil Circuit Breaker
A
T.P. Non-Auto. Oil Circuit Breaker
B
Potential Buswires for Meters
Current Trans. Ratio 200/5
Cable Boxes
Existing Incoming Feeders
Existing Metering Equipment
Existing Outgoing Feeders (6 Off)
REGULATING TRANSFORMER
Reactors
B.R. Buffer Resistance.
B.S. Bucking Switch.
C.O.S. Change-over Switch.
F.1. Fuse.
F.3. Fuse.
I.T. Insulating Transformer.
I. Isolator.
L.C. Contactor to Lower Volts.
R.C. Contactor to Raise Volts.
L.S.1 Limit Switch.
L.S.2 Limit Switch.
M. Motor.
M.A. Main Aux. Switch.
M.S. Maintaining Switch.
N.V. No Volt Coil.
P.3. Earthing Resistance.
P.A. Pilot Aux. Switch.
P.T. Potential Transformer.
R.C. Contactor for Raising Volts.
S.S. Selector Switch.
V.A. Voltage Adjustment Resist.
V.R. Voltage Relay.
Voltage Relay Panel
NV
VR
F3
VA
Earth
Conduit
PT
BR
RC
LC
IT
P3
COS
LS1
M
MS
MS1
MA
SS
BS
MS2
F1
PA
I
Regulator Movement
LS2
REGULATING SWITCH
"THE ENGINEER"

FIG. 32—TRANSFORMER BOOSTER REGULATOR ON BULK SUPPLY SYSTEM

High-Speed Marine Oil Engines.

By H. R. RICARDO, B.A., F.R.S., M.I. Mech. E.

THE lecture I am about to deliver in memory of the late Mr. Thomas Lowe Gray must deal with marine engineering, a subject in which I am indeed very interested, but about which I can claim no expert knowledge or experience. If therefore some of my statements and proposals appear outrageous, I must claim from you that tolerance which is the prerogative of either youth or inexperience. A cat may look at a king—presumably with an expression which no courtier would dare to assume. I am going to look at the marine engineer with the cynical stare of the cat, secure in the knowledge that he will not harm a mere layman.

To-night I am going to plead the case for the really light high-speed Diesel engine for marine propulsion. When suggesting to any shipbuilder the use of light high-speed engines in preference to the large heavy slow-speed engine, I have always been answered that their use would be quite out of the question, because although they may perform satisfactorily on land, they could not possibly face the hardships of a seafaring life. I am told that a marine engine is required to run year in and year out at its maximum power, and that, unlike the conditions of land service, it has to be capable of running on insecure foundations with doubtful alignment. To these criticisms I would reply that, compared with many of the services in which the small high-speed engine is already employed, that of ship propulsion would appear to be relatively easy, the more so since the speed will be nearly constant and overloading non-existent.

RELIABILITY.

One is told that the first essential of any form of marine propulsion is absolute reliability. As a frequent passenger on ships, I can but agree wholeheartedly. Many factors must be combined to achieve reliability, of which the most important are prolonged experience and meticulous attention to detail design, but even so no prime mover made by man can ever hope to be 100 per cent. reliable. We must face always the possibility, however remote, of a serious breakdown, and security can be found only in numbers. With two or three engines, security is increased enormously, and when the number of engines runs far into double figures, as I am suggesting, security is virtually infinite, however frail the individual units may be. Although marine engineers may be justly proud of the reliability of the modern marine engine, yet no patient in a sick room ever received such devoted care ; day and night it is tended, coddled, and dosed, its temperature taken and its pulse felt by relays of doctors and nurses. I am going to suggest the other extreme, that the high-speed engines should be placed in cells, padlocked, and the keys left ashore. Should an engine break down on the voyage, a chalk mark on the door of its cell will suffice for the time being, and the inquest will be postponed till the ship returns to its home port, when any engine casualties, as well as those due for overhaul, will be removed bodily and exchanged for reconditioned ones. The removal and replacement of perhaps twenty such engines could be done in a few hours only, and the ship need never be out of commission due to engine trouble.

The most important, and also the most difficult, problem we shall have to deal with will be that of the transmission of power from a large number of mechanically independent units to a single propeller shaft. I say "mechanically independent" because it is, I fear, quite out of the question to contemplate gearing a large number of units to a single shaft ; the objections to this are, I think, fairly obvious. In the first place, it would involve stringing the engines out along the propeller shaft. In the second place, it leaves the reversing problem in the air, or at least, involves it in intolerable complication. Thirdly, unless some elaborate system of automatic clutches be provided, the independence of the units, and therefore the reliability of the power plant will be weakened. We are left, then, with some form of fluid transmission, either oil, air, or electricity, and of these electricity appears to be the most practicable one.

TYPE OF ENGINE.

The type of engine I would propose for such a purpose is that which has now been developed for heavy road vehicles. There is no reason in the world why, when the production of such engines has increased sufficiently, the first cost should not fall to below £2, and, in fact, almost reach parity with the petrol engine, which is now down to about 25s. per horse-power. I would advocate this type because it has attained a far higher degree of mechanical perfection than any other ; moreover, in regard to most of its running parts, it has now become largely standardised, so that replacements are already very inexpensive. It would require modification in certain respects, but no modification, I would insist, which would affect any of its well-tried moving parts.

The output of such engines ranges up to 150 H.P. at 2000 r.p.m. or rather more ; operated at, say, 1600 r.p.m., they would each develop 100 H.P. at a very comfortable load factor and with good economy. Such engines, however, are burdened with a great deal of auxiliary mechanism essential for road service. This adds considerably to their cost and could well be dispensed with. There are, for example, a lighting dynamo, a fuel supply pump, a water circulating pump, and lubricating oil pumps, none of which would be required. All this commissariat work could be catered for much more efficiently, and much more economically, by a centralised service. The cost of all this auxiliary gear, and still more the mechanism for driving it, forms a considerable item, and its elimination will reduce substantially the already low initial cost of each generating engine. The only auxiliaries we shall need to retain on each engine are the fuel injection pump, governor, and perhaps the electric starting motor. I think it will be found, even at this present early stage, that there are many manufacturers of commercial vehicle engines who would gladly accept £3 per horse-power for a bulk order for such engines. Each engine would be coupled to an electric generator which would be bolted direct to the fly-wheel housing, thus forming a self-aligning unit.

Let us now consider the case of a relatively large vessel requiring, say, 5000 actual shaft horse-power for propulsion and, say, 1000 H.P. for auxiliary and hotel services. For such a vessel I would advocate installing a total of seventy-five high-speed Diesel-electric generating sets, each of about 100 H.P. when running at 1600 r.p.m. Allowing for a 14 per cent. loss in the electric transmission (which I think is an outside figure), we shall need a total of fifty seven generating sets for propulsion, ten identically similar sets for auxiliary services, and, if the ship is going to be very long away from a home port, it may be advisable to carry, perhaps, eight more as spares, giving a total of seventy-five sets all identical and interchangeable. The overall dimensions of each set —Fig. 1—will be approximately 6ft. 6in. long, 2ft. 6in. wide, and 3ft. 6in. high ; each will weigh slightly under $1\frac{1}{2}$ tons. Since each generating set comprises a six-cylinder engine with extremely light moving parts and balanced both as to its primary and secondary disturbing forces, no foundation will be required, but, in order to eliminate entirely any trace of third order vibrations or torque reaction, I would suggest that each set be insulated from the ship's structure by the introduction of a resilient but well-damped mounting, such as is now customary in the case of motor car engines. I would suggest that the engines be placed in rows and in several tiers, one above the other—Fig. 2. So far as their operation and mounting is concerned, their position in the ship is immaterial, but for the sake of the wiring and pipe work, it will, of course, be convenient to group them together as closely as possible. It is also an essential part of the scheme that they shall be so placed that they can readily be slid and lifted out of the ship by a deck hoist. For reasons which I will explain later, each generating set, or possibly each pair of generating sets, will be enclosed in a box whose capacity will be approximately 60 cubic feet. The entire power-generating plant, both propelling and auxiliary, together with eight reserve sets, will be represented in effect by about 110 tons of rectangular packing cases, each of 60 cubic feet capacity, which may be stowed wherever convenient, having regard to accessibility, to unloading, and to pipe work—clearly a very small bulk and weight as compared with the usual power-generating plant. The supply of cooling water, of lubricating oil, and of fuel oil, will be served out to each set from a central distributing system, with pumps in duplicate, or even triplicate, in order to ensure absolute reliability. Each generating set will have its own electric starter operated from a push-button on the bridge, and this is a point which I wish to emphasise; once up to speed, it will immediately and automatically cut into the circuit and run always at a constant speed and constant load. Except for the speed governor, there will be no engine control whatever. Each propelling set will either run at the full capacity of its fuel injection pump, or not at all, and the ship's speed will be varied primarily by cutting in or out more or less of the generating sets, not by varying the load on individual sets. I am no electrician, and the advice I have gleaned from electrical engineers with whom I have discussed the problem, has been so diversified and so contradictory that I am little the wiser for it; but I cannot think there will be any insuperable difficulty in coping with the switchgear, whether the armatures of the generators are coupled in series or in parallel. There are, I appreciate, a dozen different ways of linking up the individual sets electrically, involving alternating current in combination with rectifiers, or direct current, with the generating sets either in series or in parallel, each apparently has its attendant advantages and disadvantages. But whichever method be adopted, I would insist that the complete independence of the generating sets should be maintained, and that each should be free to cut automatically into the circuit, so soon as the engine has built up speed and voltage, and to cut out as soon as there is any reverse flow of current. Such switchgear as is required should be restricted almost entirely to the propelling motors.

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* Excerpts from the sixth Thomas Lowe Gray Lecture, Inst. of Mech. E., December 1st, 1933.

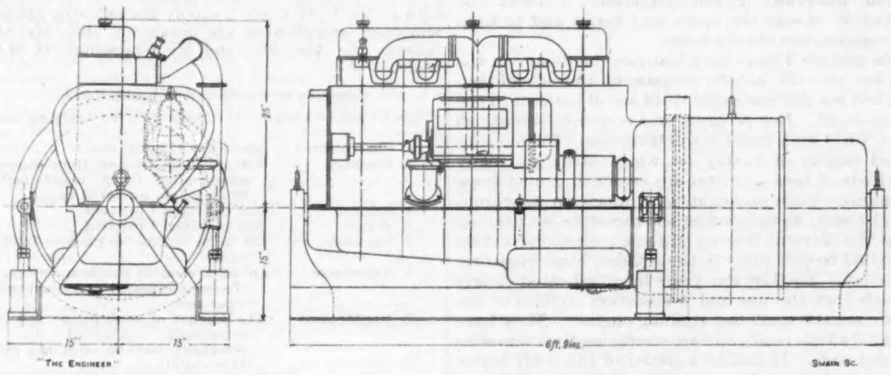

Fig. 1—Typical High-Speed Oil Engine Generator for Marine Service

Such, briefly, is the picture before my eyes of a future engine-room on shipboard—just stacks of wooden crates with occasional gangways between. It is not a romantic picture, very different, indeed, from the imposing scene of a ship's engine-room of twenty years ago. Sir Charles Parsons has already robbed the steam plant of most of its dignity, and I am proposing to substitute sheer impudence.

So much for the general scheme. I would like now to go into a little more detail and to forestall, as far as I am able, the criticisms which will be levelled at it, the first of which will, no doubt, be the cost of maintenance. A large fund of experience is now available as to the maintenance of these small high-speed engines in road service. This is a much more arduous service in almost all respects, in that the engines are required to run normally at much higher speeds than I have suggested, namely, 2000–2200 r.p.m., as against the 1600 r.p.m. I am proposing; they are constantly being started and stopped, constantly being overloaded till they are brought almost to a standstill, and are often left for long periods running idle and cold. These are hardships from which they will be free on the sea. In such engines, the principal wearing parts are the cylinder liners, the piston rings (more particularly the oil scraper rings), and the big-end bearings; other wear is trivial. The rate of wear per hour as actually measured in these small high-speed engines is no greater than in the large-slow-running types. But, in consequence of their smaller size, less wear can be tolerated; renewals must, therefore, be more frequent, but much less expensive. On balance, it will, I am satisfied, be found that the cost of renewals is far less than that of the large, slow-running engine, while the ship need never be out of commission owing to the necessity for repairs or renewals to the power-producing plant.

In the ship I am picturing there will be a total of seventy-five engines, but not much more than half this number in operation will suffice for ordinary cruising speeds and for dealing with the auxiliary services. If the ship is at sea for 4000 hours a year, then each engine will, on the average, be in operation for 2000 hours per year only. I would suggest that, after this period, it be removed for a top overhaul in a properly organised shop, where, as a matter of routine, it will be decarbonised, the oil scraper rings and valve springs renewed, the valves ground in, valve tappets and injectors adjusted, and the fuel injection pumps recalibrated. After the next 2000 hours the piston rings should be renewed, but not till after 8000 hours, or four years, should anything in the nature of an extensive overhaul be required, when the crank shafts will require regrinding, the cylinders relining, and new pistons, valves, &c., should be fitted. The cost of renewals at this stage will amount to perhaps 15 per cent. of the cost of a new engine, and the entire cost of reconditioning, including fitting, testing, &c., if made a matter of regular and well-organised routine, may amount to from £50 to £60 per engine. Allowing, therefore, for three top overhauls to one major overhaul, the cost of routine repairs and maintenance should average from £100 to £120 per engine in four years, or, say, £25 to £30 per annum. To this must be added perhaps an additional 30 per cent. to cover the hazards of accidental breakdown, making a total of about £2500 to £3000 per annum for all engine repairs and maintenance in a ship of about 10,000 tons, in which the total installed horse-power is 7500, the actual shaft horse-power at full speed 5000, and whose sea-going average is 4000 hours, or, say, 60,000 miles per annum. Not a very high figure, I think more especially when consideration is given to the fact that throughout its whole life the ship will never be out of commission for one minute for engine repairs, and that the routine overhauls will maintain all the engines in new condition and at maximum efficiency until obsolescence, not age or wear and tear, brings their lives to a close. In this connection I would mention that some of the manufacturers of high-speed Diesel engines for road vehicles are already undertaking the entire maintenance of their engines, including replacement with new engines when necessary, and including also the maintenance of all the engine auxiliaries, of the entire electrical equipment and batteries, at little more than the rate I have mentioned. As to the maintenance cost of the electrical gear, I am not, I am afraid, in a position to offer any figures, but since no batteries are involved, it is reasonable to suppose that it will be relatively very small.

As regards the details of the engine installation, I have mentioned already that the whole of the engine commissariat service should be dealt with as a centralised system. I think it is quite essential on account of the high temperature at which the engines should be run that they shall be cooled by fresh water, which will be kept flowing in a closed circuit through the water jackets of all the engines, whether they are running or not. By so doing all the engines will be kept warm, which will relieve greatly the work on the electric starters and obviate the heavy cylinder liner wear during the warming up process. The cooling water will be passed through a thermostatically controlled heat interchanger with the object of maintaining its temperature between 80 deg. and 90 deg. Cent. Outward and return circulating pipes will pass every engine cell, and it will be necessary merely to couple up the inlet and outlet connections of each engine. The sumps of all engines will drain by gravity into a hot oil tank. From this tank the lubricating oil will pass first through a centrifugal cleaner, then through an oil cooler to reduce the temperature to, say, 60 deg. Cent. From the oil cooler it will be pumped to a tank placed at a sufficient height to maintain a head equal to the normal pressure required for forced lubrication, namely, about 10 lb. to 12 lb. per square inch. From this tank there will lead a lubricating ring main to which each engine will be coupled. In this case I would suggest that the circulation of oil through each engine should take place only while the engine is running, and to this end a valve should be fitted interconnected with each starter, so that no engine can be started until its oil circulation is open. By this means each engine will be fed under pressure with a continuous supply of clean warm oil, and the danger of getting under load before the oil has warmed sufficiently to circulate freely will thus be avoided, for every engine will start with hot water in the jackets and warm oil in its bearings. Within the engine itself the lubrication system will be exactly as in a road vehicle engine, that is to say, all bearings will be fed by pressure in the usual manner, with the usual large-diameter drilled passages in place of oil piping, wherever possible. Each engine of 100 H.P. will require approximately 3 gallons per minute for the dual purpose of cooling and lubricating the bearings, so that the capacity of the oil circulating system should be about 200 gallons per minute. The fuel system should be similar to that of the lubricating oil, except of course, that no cooler is required. In order to ensure against gassing or air locks in the fuel pumps it is always preferable to maintain a continuous flow through them; but, of course, quite a low velocity will suffice. As in the case of the lubricating oil, the circulation of fuel to each individual engine will be interconnected with the starting of the engine. In like manner both the air intake and exhaust from each engine should be connected to ring mains, the latter, of course, water cooled. With such a system it may well be worth while to apply a supercharge and so raise the whole power of the plant by about 20 per cent., since this could be accomplished so easily by a single large centrifugal blower. The whole of the engine commissariat system will, of course, be operated electrically, and all vital or vulnerable parts should be in duplicate. The total power consumption of the engine auxiliary services, if in duplicate, will amount to somewhere about 50 H.P., or about 1 per cent. of the shaft horse power, excluding supercharging.

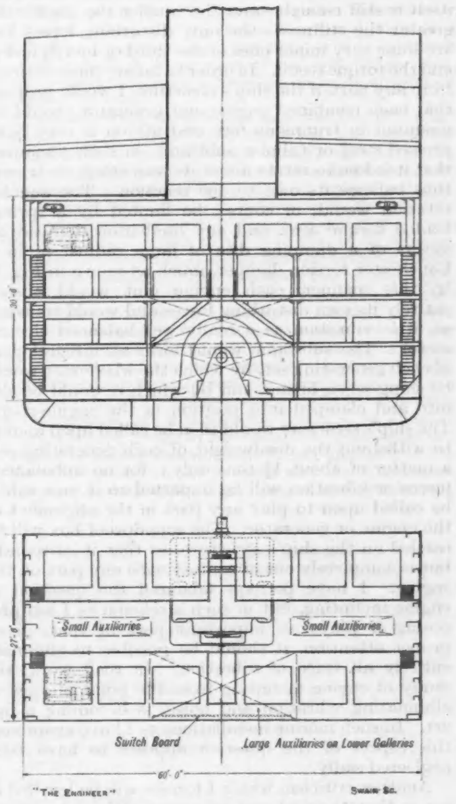

Fig. 2—Arrangement of Power Units in Ship

Although I have reckoned on a normal maximum shaft horse-power of 5000 with ten engines engaged upon auxiliary services, and eight in reserve, it is probable that in most services four or five engines will suffice for the auxiliary work when at sea, so that as many as seventy engines could at times be pressed into the work of propulsion, giving a normal shaft horse-power of 6000. If supercharged to increase the output by 20 per cent. and setting aside the use of two engines to drive the blowers, a maximum of just over 7000 shaft horse-power could be attained in emergency with all generating units in operation and supercharged.

Noise.

In order to cope with the noise difficulty, and at the same time to discourage any meddling with the engines by those on board, I would propose that each generating set or pair of generating sets should be enclosed entirely in a double-walled wooden soundproof box, well ventilated by connection to deck ventilators, or even a false funnel. This box will rest on the ship's structure entirely out of contact with the engine or its mounting. A glass window should be provided in each box through which an occasional visitor to the engine-room can see the commutator of the generator, a thermometer on the exhaust pipe, possibly, though not necessarily, an ammeter, and the crank case air vent. The amount of smoke from the latter will reveal the general condition of the piston rings and indicate when the time is drawing near for a top overhaul. Thus enclosed, the generating sets will sound like bees on a summer's afternoon, and the solitary engine-room clerk will be able to smoke his pipe of peace. Since the fuel injection pumps will have been calibrated ashore and set to give a maximum delivery sufficient for 100 H.P. only, at 1600 r.p.m., there can be no possibility of overloading, and I would insist that any adjustment to the fuel pumps or governors be sealed, lest some engineer cracksman succeeds in breaking and entering the engine's cell. All engines should, I suggest, be started and stopped by means of a remote control, either from the main switchboard or the bridge. Lights on the switchboard and in each engine cell will indicate which engines are in operation at any moment. The engine-room clerk will be expected to keep records of the number of hours run by each generating set, of the total fuel and oil consumption, and it will be his business also to take an occasional stroll round and to chalk mark for the benefit of the engineer ashore, any set which is persistently showing an exhaust temperature much above the average or which is showing excessive fuming from the crank case breather.

VIBRATION.

In a six-cylinder engine all primary and secondary disturbing forces are balanced completely, except in so far as the internal stresses they exert on the structure are concerned. Provided the engine structure itself is stiff enough—and the smaller the engine the greater the stiffness—the only disturbing forces left are some very minor ones of the third or fourth order, and the torque recoil. In order to isolate these entirely from any part of the ship's structure, I would propose that each combined engine and generator should be mounted in trunnions fore and aft on a very light pressed steel or tubular subframe, in such a manner that it is free to rotate about its own crank shaft, and thus balance its own torque reaction. The augular rotation would, of course, be limited by a spring-loaded torque arm, and any oscillation damped by means of a damping disc of large radius, as in a Lanchester torsion damper, much as shown in Fig. 1. In this manner, each engine unit would absorb entirely its own disturbing forces and would transmit as little vibration as a really well-balanced electric motor. The subframe would form an integral part of each generating set, by which the whole unit would be slung when lifting, and by which it would be slid into and clamped into position in the engine-room. The ship's structure would then be called upon merely to withstand the deadweight of each generating set, a matter of about 1½ tons only; for no unbalanced forces or vibration will be imparted to it, nor will it be called upon to play any part in the alignment of the engine or generator. The soundproof box will be carried on the ship's structure, so that it surrounds, but is completely out of contact with any part of, the engine. I have perhaps laboured the question of engine mounting, but in such a scheme as I am proposing it plays an important part in that, given proper attention, it should be possible to eliminate entirely all trace of vibration. In road work, the study of engine mounting from the point of view of eliminating vibration and noise, is becoming a fine art. In such marine installations as I have examined, this aspect of the question appears to have been neglected sadly.

Another criticism which I foresee will be levelled at me is that the fuel and oil consumption of such an equipment will be excessive. If this is so, of course, the scheme will lose much of its charm, but I think I can show that it will not be appreciably, if any, higher than that of a direct-driving Diesel plant. In the first place, thanks to their high speed, their light moving parts, and perfect alignment which ensures low internal friction, the specific fuel consumption of these small engines is at least as good as, and usually even better than, that of the large slow-running type. The efficiency of the Diesel engine gains nothing with size, and small six-cylinder engines of about 100 H.P. can maintain a fuel consumption of well under 0·4 lb. per B.H.P.-hour over a wide range of load or speed, and over very long periods. The Gardner commercial vehicle engine, to take a good example, has in ordinary every-day service a fuel consumption of only 0·37 lb. per B.H.P.-hour, when driving the whole of its auxiliary mechanism, and even better results than this can and would be obtained under the very favourable running conditions I am providing for. What large slow-speed engine can better this? After 2000 hours without a top overhaul, the consumption will have increased from 0·37 lb. to about 0·39 lb. per B.H.P.-hour, so that we may take the mean average as 0·38 lb. I have suggested that the mean overall efficiency of the electric transmission will be 86 per cent. at cruising speeds, which will give a fuel consumption of 0·442 lb. per actual shaft horse-power-hour, a figure only slightly inferior to that of the slow-speed type. Although the lowest consumption, in terms of shaft horse-power, of my multiple-engine proposal may not be quite so low as that of the large direct driving plant under favourable conditions of speed, yet in my proposal this same consumption will hold good for all speeds from dead slow to full speed (excepting only in so far as the efficiency of the propelling motors will vary slightly with speed). So far as the generating sets are concerned, the consumption per kilowatt-hour will be entirely unaffected by any variation of load from less than 2 per cent. upwards. With regard to lubricating oil consumption, this ranges from $^1/_{300}$ lb. per H.P.-hour, when the oil scraper rings are new, to about $^1/_{150}$ lb. per H.P.-hour after 2000 hours, say, an average of $^1/_{20}$ gallon per hour for each generating set. Under the operating conditions I have envisaged the very cheapest lubricant procurable will be all that is needed. If we take 4000 S.H.P. as the normal cruising condition, then the fuel and oil consumption of the propelling engines will be approximately 14 tons and 50 gallons per day respectively.

I have stressed the argument that all engine repairs and overhauls should be carried out ashore in a properly organised and equipped maintenance shop, where, since all engines are identical and all parts interchangeable, the work can be undertaken as a continuous routine. There is no reason, however, why the repairs and maintenance should not be carried out on board, for the staff and equipment needed are extremely small. Where a ship is leading a purely vagabond existence this may be necessary; but in the case of ships which visit their home ports at regular intervals, it will—obviously, I think—be preferable to save the space and hands and to keep the maintenance shop ashore.

The picture I have sketched may be dreary in the extreme—it will be the despair of the school-boy, who will not get one single thrill out of his visit to the engine-room. But progress and economic conditions must, I feel sure, trend in this direction. The monster Diesel engine of to-day on whose structure many hundreds of tons of metal are lavished, cannot hope to endure. Such an engine is as much an anachronism, I think, as the prehistoric monsters we gaze up at in the Natural History Museum, which have long since had to give place to the smaller, lither creatures of to-day. The last few years have indicated clearly enough that the internal combustion engines of the future are the small fast-running engines. They have invaded all the roads, and are stretching their tentacles far and wide. It can be a matter of time only before they invade our shipping also The time has now arrived, I think, when the marine engineer should consider seriously how he will deal with their accommodation, their catering and their hygiene, lest they swarm upon him unawares and overwhelm him.

Liquid Fuels from Coal for Naval Purposes.*

By Eng.-Capt. S. H. DUNLOP, R.N.

THE importance to this country of being independent of external sources of supply for liquid fuel for the Navy is apparent to everybody, and the subject has naturally attracted a considerable amount of public interest. Unfortunately, many extravagant and unsubstantiated claims have been made by the various rival interests which have given rise to a good deal of controversy and doubt. It is proposed, however, to keep this paper as far as possible beyond the realms of controversy, and to confine it to an account of the experiments and trials carried out in H.M. Naval Service with liquid fuels produced from coal, together with an explanation of the Admiralty requirements in connection with such fuels.

So far as can be traced at present, the Admiralty first turned its attention to the combustion of coal distillates in 1867–1870, when Captain Selwyn carried out some experiments in burning creosote in marine boilers at Woolwich Dockyard. At that time creosote was a waste product from the distillation of tar for chemical purposes, and it appears that the matter was allowed to lapse owing to the limited supplies of fuels possessing the qualities then considered necessary. From 1898 onwards continuous experiments in burning oil fuel were carried out in H.M. ships, and in 1912 it was decided that the boilers of all new surface warships should be fitted for burning oil fuel only. This increased dependence upon imported fuels naturally revived the interest in home-produced fuels, and any developments giving promise in this direction have been encouraged by the Admiralty to the utmost extent.

The most obvious and accessible sources of such fuels were, of course, the considerable shale deposits of this country, which have now been either actively worked or explored for many years. These include the Kimmeridge shale beds in Dorset and other beds in Norfolk, the utilisation of which has been frequently suggested, but attempts in this direction have been abandoned owing to the high percentage of sulphur; also the shale deposits of Scotland which have been worked for many years, and from which many thousands of tons of oil have been extracted and used to our great content during the war and earlier periods. Owing to competition with imported oils, the production of shale oil as a boiler fuel is no longer economically possible.

CREOSOTE PRODUCED BY THE HIGH-TEMPERATURE DISTILLATION OF COAL.

The possibility of using creosote for admixture with petroleum oil fuels was considered in the early stages of the introduction of oil fuel burning in the Navy, but prior to 1913 it was the practice to specify that the creosote must be cooled to some low temperature in order that all naphthalene present in it, which would be thrown out of solution at this temperature, should be removed before the residual oil was used in an oil fuel installation. It was required also that all naphthalene which would solidify at, say, 32 deg. Fah., should be removed before the admixture with ordinary petroleum oil fuels, as it was feared that in the course of using such mixtures solid naphthalene might separate out in the tanks and pipes. In 1913 the Admiralty chemist found that it was not necessary to remove from creosote the naphthalene which would solidify at temperatures down to 32 deg. Fah. before mixing it with petroleum oil fuels, provided the resultant mixture did not contain more than 7 to 8 per cent. of naphthalene. In fact, he found that the presence of up to 7 or 8 per cent. of naphthalene had a beneficial effect on a mixture of creosote with a thick petroleum fuel oil, as it caused the mixed oil to be less viscous than the original petroleum fuel oil.

As a result of this discovery, practically half a million tons of creosote was purchased by the Admiralty during and just after the war for admixture with petroleum fuel oils, in order to augment our supplies of liquid fuel. This creosote contained approximately 18 per cent. of naphthalene, and the mixtures were so arranged that the resultant naphthalene content did not exceed 7 per cent. For some years after this, no purchases of creosote were made, but in 1929 owing to the failure of the American market for this product, large quantities became available, and in order to assist the trade the Admiralty obtained 10,000 tons of creosote which was mixed with twice its bulk of Trinidad oil fuel and issued to the Fleet. It was burned satisfactorily, and no insurmountable difficulties were experienced. In 1931, on being approached by the interests concerned, the Admiralty agreed to consider the purchase of further quantities of creosote, and with a view to facilitating supply the following amended temporary specification was drawn up, after discussion between the Admiralty and the representatives of the trade:—

Admiralty Specification for Creosote Fuel Oil.

The oil will be required to comply with the following specification:—

1. Flash point .. Not below 172 deg. Fah.
2. Viscosity .. The oil shall be free from separated solids after being maintained at 60 deg. Fah. for seven days.
3. Sulphur .. .. Not to exceed 1 per cent.
4. Water .. .. Not to exceed 1 per cent.
5. Tar acids .. Oil to be as free as possible from tar acids.
6. Anthracene .. Oil to be sensibly free from anthracene. (To be interpreted as a maximum of 1 per cent.).
7. Naphthalene.. The amount of naphthalene and other compounds estimated by the Admiralty method must not exceed 24 per cent.
8. Pitch .. .. Not to exceed 2 per cent.
9. Oil to be free from sediment or other impurities likely to choke the burners.
10. Oil to be practically free from inorganic acidity.

Owing to the financial crisis, the negotiations for the purchase of this fuel had, however, to be abandoned, and no further supplies have been obtained from this source. Relaxations in the producers' favour, as compared with previous specifications, are embodied in clauses 2 and 7. In clause 2 the temperature specified for the test was raised from 32 deg. to 60 deg. Fah., and this admits oils of a quality which would necessitate continuous heating from the collecting point till mixed in the storage tanks with the proper proportion of petroleum oil fuel. The limiting percentage of naphthalene permitted by clause 7 would require mixing the creosote with about three times its amount of a petroleum oil. These relaxations add very considerably to the cost of collection, transport, storage, and supply, and involve some loss of flexibility in the arrangements at naval fuelling depôts. It should be remarked that the presence of more than a very small proportion of anthracene has, according to information at present available, a harmful effect on the *personnel* handling the oil; further, tests have shown that if more than 0·25 per cent. of it is present in a mixture with petroleum fuel oil, anthracene paste is liable to be deposited.

The pitch determined as a residue on distillation is limited to a maximum of 2 per cent., as a higher content has been found to cause trouble by precipitation when mixed with petroleum oils.

The calorific value of the creosote supplied to the Admiralty was from about 16,000 to 17,000 B.Th.U. per lb.

FUEL OIL PRODUCED BY THE LOW-TEMPERATURE CARBONISATION OF COAL.

In 1912 the problem of developing home sources of supply of fuel for the Navy was examined exhaustively by a Royal Commission, of which Lord Fisher was Chairman and Dr. G. T. Beilby (later Sir George Beilby) one of the members. Amongst other things, Dr. Beilby made a report to the Commission on "The possibility of a development of a new carbonising industry founded on the distillation of bituminous coal at a temperature much below that used in gas retorts and coke ovens." The data mainly used in the report were obtained from experimental work on a small industrial scale carried out in Glasgow under the direction of Dr. Beilby. As a result of his experiments, Dr. Beilby was able to show—and what he found largely holds good to this day—that by weight from 5 to 8 per cent. only of the coal carbonised could be obtained as a fuel oil, and that the really big problem was not so much the production of the fuel as the disposal of the coke, which amounted to from 65 to 75 per cent. of the original coal. However, the war intervened and the work was temporarily suspended.

When the Fuel Research Station at Greenwich was built and put into operation at the close of the war, with Sir George Beilby as Director, work on low-temperature carbonisation was revived on a larger scale, mainly with a view to the production of a smokeless domestic fuel, and it has been pursued actively on an experimental scale ever since. Concurrently, the production of smokeless semi-coke, with fuel oil as a by-product, was taken up by quite a number of commercial concerns, although it was not till about 1927 that fuel oils whose properties approximated to Admiralty requirements were offered for test and trial from such sources.

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* The Institution of Engineers and Shipbuilders in Scotland, November 7th, 1933.

Before proceeding with the narrative of events, it is proposed to digress somewhat and give a brief account of some of the products of the process of low-temperature carbonisation of coal. As a preliminary, the following extract from the report of the Fuel Research Board for the period ending December 31st, 1924, will probably be of interest, as showing the distinction between low and high-temperature carbonisation of coal :—

"By low-temperature carbonisation is understood the destructive distillation of coal at temperatures in the region of 600 deg. Cent., instead of at the higher temperatures used in the gas and coke oven industries. At the higher temperature more of the coal is converted into gas and less into tar and coke, while from suitable coal a stronger coke is left behind; incidentally, the yield of ammonia is also much greater. At the lower temperatures enough combustible volatiles are retained in the coke to make it catch fire and burn readily, though not enough to generate smoke; larger quantities of tar are collected without being decomposed into gas, while from the gas itself as well as from the tar some light spirit can be extracted and converted into motor spirit. Low-temperature carbonisation accordingly offers a possible, and probably the only possible, means of treating coal so as to obtain a source of oil fuel and motor spirit, together with a smokeless fuel that can be burned on any domestic grate."

By the application of low-temperature carbonisation to 1 ton of bituminous coal, there is produced approximately 14 cwt. of semi-coke, from 16 to 20 gallons of coal tar, from 2½ to 3 gallons of motor spirit, and 4000 cubic feet of gas. By distilling the coal tar a fuel oil which will meet Admiralty requirements can be produced, and the amount of the oil varies from 35 to 50 per cent. of the coal tar, according as the tar acids are removed from the fuel or not. In other words, the amount of suitable fuel oil produced per ton of coal is from 5 to 8 gallons, or from 2·5 to 3·5 per cent. by weight. By treating cannel coal, the tar yield can be increased to about 50 gallons per ton, but such coal, although plentiful in the aggregate, is distributed in comparatively small patches in the United Kingdom, and mining difficulties render it unsuitable as a potential source of home-produced oil fuel in an emergency.

At the beginning of 1927 the Fuel Research Station supplied a small quantity of fuel oil to the Admiralty Engineering Laboratory at West Drayton for examination of its behaviour in a compression ignition engine of the submarine type. After slight modifications to the atomising arrangements, satisfactory running was obtained at full power with a reasonable fuel consumption using normal blast pressure. In November, 1928, 10 tons of oil fuel prepared by the Fuel Research Station was sent to the Admiralty Fuel Experiment Station at Haslar for burning under boilers of the naval type. The Admiralty Chemist's report on the chemical properties of the oil as received at Haslar was as follows :—

Specific gravity at 60 deg. Fah. ..	1·004
Flash point, deg. Fah.	165
Viscosity, Redwood II., at 60 deg. Fah., secs.	12
Viscosity, Redwood II., at 32 deg. Fah., secs.	53
Setting point, deg. Fah.	Below 20
Free mineral acidity	Nil
Sulphur, per cent.	0·69
Water, per cent.	2
Appearance	Brownish black opaque
Sediment, per cent.	Below 0·005
Odour	Coal tar
Crude tar acids, per cent.	34·7
Naphthalene	Nil
Anthracene, per cent.	0·4
Calorific value, B.Th.U. per lb. ..	16,380

A small quantity of this oil was burned in a 900 lb. per hour sprayer, but it was not found practicable to burn the oil without pulsations. The oil was then heated, in contact with water, to 190 deg. Fah., and allowed to settle overnight. The fuel oil was drained off from the surface, and it was found that the water content had been reduced from 2 to 0·7 per cent. The treated oil burned quite satisfactorily under the boilers at Haslar, and in a subsequent trial in H.M.S. "Tyrant," without pulsations. The boiler efficiency obtained was as high as that when using Texas oil. Mixtures of the coal oil fuel with equal proportions of Texas, Burma, Borneo, Persian, and Trinidad petroleum oil fuels showed no signs of separation or solid deposits after standing for ten weeks. The medical officer who attended the trials in H.M.S. "Tyrant" reported that no discomfort was experienced from the fumes, and air samples taken and tested were satisfactory.

As a result of these trials the Admiralty prepared a tentative specification and forwarded it to all known concerns producing oil from coal by low-temperature carbonisation. They were asked to state whether they would be prepared to forward small samples of the oil for preliminary tests by the Admiralty Chemist and at the Admiralty Fuel Experimental Station, Haslar. The specification since then has been slightly revised, and is now as follows :—

1. The flash point shall not be lower than 175 deg. Fah. (Pensky-Marten).
2. The proportion of sulphur contained in the oil shall not exceed 1 per cent.
3. The oil shall be free from inorganic acidity and sensibly free from anthracene and sediment.
4. The crude tar acids shall not exceed 36 per cent.
5. The quantity of water delivered with the oil shall not exceed 0·5 per cent.
6. The viscosity of the oil shall not exceed 1000 secs. at a temperature of 32 deg. Fah., as determined by Redwood's standard viscometer pattern II., Admiralty type, for testing fuel oil.
7. The pitch shall not exceed 2 per cent.
8. Solids separating out after maintaining the oil at a temperature of 32 deg. Fah. for seven days shall not exceed 0·1 per cent.
9. The oils shall be free from earthy carbonaceous or fibrous matter or other impurities likely to choke the burners.

In all, twenty-five concerns were communicated with, and fourteen forwarded samples for preliminary tests. Six of these firms sent samples which approximated to the Admiralty requirements sufficiently closely to justify placing orders with them for 20-ton lots for actual burning tests at Haslar and in H.M.S. "Tyrant." The trials of these fuels were carried out in 1930 and 1931, and in general were quite satisfactory. In one fuel a quantity of wax of a hydro-carbon type was found on the surface when the oil was delivered, and in another there was an excess of water, but on the whole the 20-ton lots conformed quite well to the samples. Exhaustive mixing trials were carried out with these oils and various petroleum oil fuels in ratios of 2 : 1, 1 : 1, 1 : 2, and also with the coal oils themselves. These trials showed that the mixtures remained quite stable, and no objectionable deposits were found to separate out, provided the pitch content of the coal oil was kept under about 2 per cent. The Admiralty Chemist's report on a typical fuel supplied for these trials was as follows :—

Specific gravity at 60 deg. Fah. ..	1·01
Flash point (Pensky-Marten), deg. Fah.	186
Viscosity, Redwood II., at 60 deg. Fah., secs.	9
Viscosity, Redwood II., at 32 deg. Fah., secs.	25
Sulphur, per cent.	0·73
Water (by volume), per cent. ..	1·12
Mineral acidity	Nil
Appearance	Dark brown, transparent
Sediment (total insoluble in benzene), per cent.	0·046
Naphthalene, per cent.	2·4
Anthracene	Trace
Pitch, per cent.	2·2
Crude tar acids, per cent.	27
Ash, per cent...	0·03
Calorific value, B.Th.U. per lb. ..	16,930

Ultimate Analysis.

	Per cent.
Carbon	81·17
Hydrogen	8·79
Nitrogen..	0·83
Sulphur	0·73
Oxygen	7·33
Water	1·12
Ash	0·03

A report of an evaporation trial of this fuel and of a similar trial of Texas fuel oil for comparison will be found in the Appendix.

During 1932, after a preliminary trial at Haslar, the Admiralty purchased 350 tons of a low-temperature carbonisation fuel oil from which the tar acids had been extracted. According to information received from the Fuel Research Station, the tar acids in a fuel reduce the calorific value by an average amount of about 35 B.Th.U. per lb. per 1 per cent. of tar acids. Consequently, the calorific value of the fuel purchased was considerably higher than that of those previously supplied, as will be seen from the following typical analysis :—

Specific gravity at 60 deg. Fah	0·970
Flash point (Pensky Marten), deg. Fah ..	178
Viscosity, Redwood II., at 60 deg. Fah., secs.	55
Viscosity, Redwood II., at 32 deg. Fah., secs.	130
Sulphur, per cent.	0·85
Water, per cent.	0·10
Inorganic acidity	Nil
Appearance	Brown, opaque
Sediment, per cent.	0·01
Naphthalene, per cent.	2·2
Anthracene	Trace
Pitch (residue on distillation), per cent. ..	2·1
Crude tar acids, per cent.	2·0
Spontaneous ignition temperature in oxygen, deg. Cent.	323
Calorific value, B.Th.U. per lb.	17,800

Ultimate Analysis.

	Per cent.
Carbon	87·07
Hydrogen	9·85
Oxygen	0·99
Sulphur	0·85

The oil was delivered to H.M. destroyer "Westminster," attached to the Home Fleet, and proved to be satisfactory on service, which included a run of two hours at full power. There were no unpleasant fumes given off, and the oil had no deleterious effect on the *personnel* handling it.

Early in the present year the Admiralty arranged to purchase small monthly amounts of this fuel for a year, amounting in the aggregate to 3000 tons in 1933. As the demand for tar acids for other requirements is limited, a portion of the deliveries of the fuel oil will be of a quality similar to that referred to above, the remainder being sensibly free from tar acids. Table I. gives a comparison of the calorific values taken on a weight and on a volume basis, and shows that the endurance of a ship is only slightly affected by the use of low-temperature carbonisation fuel oils.

Table I.

	Specific gravity.	Calorific value, B.Th.U. per lb.	Calorific value, B.Th.U. per gall.
Persian fuel oil	0·895	19,060	170,500
Trinidad fuel oil	0·955	18,810	179,600
Low-temperature carbonisation oils free from tar acids	0·966	17,830	172,250
Including tar acids	1·014	16,780	170,485

From the foregoing it will be seen that, although a fuel oil which is acceptable for naval purposes can be produced by the low-temperature carbonisation of coal, the supply is still very limited. So far as can be ascertained, out of some 35 million tons of coal used in this country for domestic purposes, at present approximately 220,000 tons per annum is treated by low-temperature carbonisation processes. From this amount of coal about 7000 tons of a fuel oil suitable for naval purposes could be produced. We have therefore a long way to go before the effect is likely to be appreciable upon even the annual peace-time requirements of the Navy.

HYDROGENATION.

During 1930 the Admiralty purchased a small quantity of fuel oil produced by the hydrogenation of coal, for trial at the Admiralty Engineering Laboratory in compression ignition engines of the submarine type. The oil was found to be quite suitable for use either in blast or solid injection engines, provided slight modifications were made to the spraying conditions. The oil had the following properties :

Specific gravity at 60 deg. Fah.	0·913
Flash point (closed), deg. Fah.	188
Viscosity, Redwood II., at 32 deg. Fah., secs.	56
Calorific value, B.Th.U. per lb.	18,600
Spontaneous ignition temperature in oxygen, deg. Cent.	288
Sulphur, per cent.	0·48
Ash, per cent...	0·01
Hard asphalt, per cent...	0·01
Soft asphalt, per cent.	0·01
Water	Nil
Acidity	Nil

When treated by hydrogenation 1 ton of bituminous coal free from ash and moisture is stated to yield about 175 gallons of petrol or fuel oil—that is, from 60 to 70 per cent. by weight—but, in addition, over 2 tons of coal, as mined, is required for steam raising, hydrogen production, &c. Thus, 1 ton of petrol or fuel oil can be produced by the expenditure of from 3½ to 4 tons of coal, which is a higher yield of liquid fuel per ton of coal than can be obtained by any other known process. There is, however, at present comparatively little difference in the cost of producing petrol, Diesel oil, or furnace oil, and production would therefore naturally be concentrated on the fuel fetching the highest price. To the Admiralty the process is at present of direct interest principally as a possible source of supply of fuel for submarines, and in the more distant future as a potential source of furnace oil. It is of further interest in encouraging home industries and thereby limiting to some extent the importation of what is now an essential commodity, thus relieving somewhat the Navy's burden in the event of war.

COAL-OIL FUEL.

In a paper* read before the Society of Chemical Industry, Professor Brame gives most of the information available on the subject. As he states, extensive experiments with coal-oil mixtures were carried out in the United States during the later years of the war by Lindon Bates and H. O'Neill, who were afforded considerable assistance by the United States Government. They used soap as a stabiliser and claimed that 1 per cent. of this substance retained from 30 to 40 per cent. of coal dust (95 per cent. of which passed through a 200-mesh sieve) in suspension for several months.

In the year 1918 the material was tried out in a small gunboat, U.S.S. "Gem," and the trials were witnessed by Admiralty representatives. Later, the Admiralty obtained a small quantity from America, and carried out a few burning trials at Haslar. The trials were abandoned, however, principally owing to doubts as to the stability of the mixture under service conditions where the possibility of access of water to the fuel cannot be ignored. Interest in the subject was revived last year by the publicity given to the successful trial of a coal-oil fuel in the Cunard liner "Scythia." It has been stated that the Cunard mixture does not contain a stabiliser and that the coal dust remained in suspension for many months without any appreciable deposit. It is possible that this fuel is applicable to certain ships of the mercantile marine specially adapted for the purpose, where the additional weight and space necessitated by its use and the low rates of burning can be accepted. It is unsuitable, however, as a fuel in modern warships, owing to the difficulties of transport and storage and to the accumulation of ash and soot in the boiler furnaces and on the external surfaces of the tubes when being burned at the high rates of forcing necessary in H.M. ships.

APPENDIX.

	Low-temperature carbonisation oil fuel.	Texas oil fuel.
Duration of trial, hours	2	3
Pressure of evaporation, lb. per sq. in.	220	220
Feed water temperature, deg. Fah. ..	80	72
Temperatures—		
Deck, deg. Fah.	64	58
Boiler-room, deg. Fah	87	89
Funnel, deg. Fah	711	708
Fuel—		
Oil burned, lb. per hour	4,712	4,448
Oil, lb. per sq. ft. of heating surface per hour	1·35	1·27
Water—		
Actual water evaporated per hour, lb.	51,785	54,125
Equivalent water evaporated per hour from and at 212 deg. Fah., lb.	61,510	64,735
Water per lb. of oil from and at 212 deg. Fah., lb...	13·05	14·55
Gas analysis by volume—		
CO_2, per cent.	12·1	13·25
CO, per cent.	0·01	0·17
O_2, per cent.	5·7	1·87
N_2, per cent.	82·1	84·7
Air—		
Air supplied per lb. of fuel, lb. ..	16·44	16·46
Air theoretically required per lb. of fuel, lb.	12·19	14·48
Excess air, per cent.	34·9	13·7

Heat balance—

	B.Th.U.	Per cent.	B.Th.U.	Per cent.
Heat to steam	12,660	74·8	14,123·1	74·2
Loss with dry funnel gases	2,688	15·9	2,629·3	13·8
Loss by hydrogen in fuel..	1,072	6·4	1,677·3	8·8
Loss by incomplete combustion, radiation and other losses	490	2·9	620·3	3·2

	Low-temperature carbonisation oil fuel.	Texas oil fuel.
Total gross efficiency, per cent.	74·8	74·2
Sprayers—		
Output, lb.	942	890
Number in use	5	5
Oil pressure, lb. per sq. in.	142	147
Temperature of oil at burners, deg. Fah. ..	105	200
Air pressures—		
Boiler-room, in. of water	4·3	4·25

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* Journ. Soc Chem. Indus., 1932, vol. li, p. 855.

South African Engineering Notes.

(By our South African Correspondent.)

Port Elizabeth's New Harbour.

Thousands of people from the Midland and Eastern Province areas thronged Port Elizabeth on Saturday, October 28th, to be present at the opening of the first quay of the new harbour. The ceremony was performed by the Minister of Railways and Harbours (Mr. O. Pirow), the first ship to tie up alongside the first deep-water berth ever constructed in Algoa Bay being the flagship of the African Squadron, H.M.S. "Dorsetshire." The new work, which was described in our issue of December 4th, 1931, is named the Malan Quay, or the No. 1 Quay, and has swallowed up the old north jetty and runs due east from the shore for 2000ft. It will provide berthage for four ships when completed. Beyond its end a rubble mole will extend for a further 1550ft. Should the trade of the port continue to expand, this mole will be converted into an extension of the quay. The Malan Quay is far from completed; in fact, three years, more work will be required, and at present even the berth now opened is totally unequipped. The construction will, however, have advanced sufficiently by the end of the year to permit steamers to berth at the wharf, but they will have to use their own derricks for loading and discharging for some months. The plans provide for completing the cranes, sheds, &c., by June of next year. The harbour scheme now being proceeded with at Port Elizabeth is planned to enclose an area of between 260 and 300 acres, and to provide berthage for eleven large steamers simultaneously, while, should traffic justify it in the future, additional wharfage could easily be provided without departure from the existing plan.

On the south and east sides the harbour is protected by the south breakwater—already completed—which is 4850ft. in length. The northern side is provided by the Malan Quay. Running parallel with this Quay from the shore, and providing 1250ft. of wharfage, will be No. 2 Quay. The work on this section, which lies 1000ft. south of the Malan Quay, and that much nearer to the breakwater, has just commenced. This will be the mail vessel wharf. Deep-water berthage at No. 2 Quay will be available within about three years from now. From a point in the breakwater, somewhere over half-way of its length, a mole will project towards the extremity of the Malan Quay, and with it form the dock entrance with a width of 800ft. This latter mole will be about 750ft. in length. With the completion of the harbour there will be safety within its boundaries. At present passengers embark in tugs to go ashore and return on board, and the south-east wind continually interferes with the handling of cargo. Probably at no other port in the world has so much cargo been landed and shipped under such impossible conditions. The lightermen of Algoa Bay deserve great credit for their skill, endurance, and speed have battled triumphantly for years with the huge drawbacks of Port Elizabeth as a cargo port. With steamers able to come alongside quays and be discharged by cranes a certain amount of cargo, which, on account of its weight, had to be discharged at East London or Durban, will be landed at Port Elizabeth, and probably cargo intended for Rhodesia and parts of the Union served by the railways from Port Elizabeth will be diverted from East London, Durban, Delagoa Bay, and Beira, but it is not likely that it will be of such proportions as to constitute serious losses to those ports.

The total cost of the present work in hand, excluding the cost of the breakwater and the contemplated mole from the breakwater, will be £1,413,420. When the port is completed the total expenditure will have been in the neighbourhood of £3,500,000. The original scheme, as planned at the beginning of the century, called for a breakwater following much the same line as the one built, but the northern section of the works would have started from the shore so much more to the north that the area of water enclosed would have been 900 acres. In 1913 a modified scheme to cost £8,000,000 was approved, and in 1919 a start was made with the south breakwater. In 1930 Mr. J. F. Craig, Senior Harbour Engineer of the Union, evolved the scheme of to-day, which was recognised as a practical scheme from the financial point of view, his plans ensuring a saving of £5,000,000. It is to Mr. Craig that Port Elizabeth owes the realisation of its long-deferred dream.

Alcohol as Motor Fuel.

A scheme which may make South Africa independent of outside supplies of motor fuel and which may, in addition, greatly reduce the cost of exporting refrigerated fruit, is expected shortly to be entered upon. Dr. Henry Arnstein, stated to be one of the foremost chemical engineers in the United States, has been engaged as a technical expert by a company out here, which is about to be registered for the manufacture of alcohol. South Africa produces more maize and sugar than it could consume, and it is with this surplus production that it is proposed to deal. The Union imports a large variety of chemical products used in the manufacture of such articles as toothpaste, shoes, dyes, pharmaceutical goods, textiles, paints, varnishes, and a host of others. Such chemicals could be manufactured in South Africa, but before that is possible a large volume of cheap alcohol is necessary; also, as there are no petroleum resources in the country, all motor fuel has to be imported. In South Africa it should be possible to produce fuel alcohol at exceedingly low cost.

New Rolling Stock.

One of a number of indications of improved industrial conditions in the Union of South Africa is furnished by the considerably increased activity in the railway workshops, particularly those at Durban, where practically all the staff is now working on a five-day basis, and the great majority of the artisans who were, for financial reasons, de-graded to the rank of labourers, have been reinstated to their former positions and rates of pay. The construction work in hand includes two hundred 50-ton high-sided coal wagons, and nine second-class main line corridor coaches, while authority is expected for a further thirteen main line coaches. An order for one hundred fruit wagons for use in the Western Province has recently been completed, and all the vehicles were in service early in July. The nine second-class coaches are required to replace some of those destroyed by a fire at the Salt River Works. They are due for completion in time to cope with the extra traffic always experienced at the end of the year, which, owing to the improvement in trade, will be much greater than in either of the past two or three years. The coal wagons are of an improved type designed by the Administration's own staff, having underframes with central box girders, giving increased strength without increased weight, and with bogie centres running in oil baths to ensure ample lubrication.

Electrical Work at Pretoria.

The first positive steps in connection with the development which is expected to follow in Pretoria on the production stage being reached at the works of the South African Iron and Steel Industrial Corporation at Pretoria West, are now to be taken. The Pretoria City Council proposes to take immediate action, and intends to apply to the Administrator for a loan of approximately £350,000, which is to be expended on extending the existing electricity supply scheme. When the first estimate of the electric power required by the Iron and Steel Corporation was made, it was calculated that the Pretoria Electricity Supply Department would have to provide only 3000 kilowatts per annum. Recently, the Iron and Steel Corporation informed the City Council that its needs would be 9000 kilowatts per annum. The existing plant is incapable of supplying this demand, and the City Council will have to spend £75,000 on the extension of mains, plus £275,000 on the purchase of new plant, which will include a 20,000-kilowatt turbine and new boilers.

Electrification of Main Line.

The electrification of the stretch of main line between Glencoe Junction and Vryheid (Natal) is to be begun as soon as the Harrismith-Ladysmith electrification scheme is completed. The cost will be roughly £300,000, and on the two lines it is expected to effect a saving of just under £70,000 per annum. At present the main line is electrified from Cate Ridge to Glencoe Junction, and continued electrification will therefore spread from there in the form of the letter V. The route mileage from Glencoe to Newcastle is a little over 37 miles, and from Glencoe to Vryheid 60 miles, giving a total of 97 miles. With the prospect of continuation to Newcastle and Vryheid, there will be a network of electrified lines in Natal covering 526 track miles, and altogether South Africa will still further advance its position as owner of the second largest electrified system in the world, and the largest in the Empire, its magnitude only exceeded by the United States' Chicago-Milwaukee electric system.

New Enterprises.

The Union Government has decided to proceed immediately with the construction of the largest irrigation scheme ever undertaken in South Africa. A sum of £4,000,000 is to be spent on the Vaal-Hartz scheme. This project, which will take five to six years to complete, will give employment to 3000 workers, and will result in over 120,000 acres of land being put under irrigation. The scheme entails the damming up of the Vaal River, and by means of a canal taking water through a neck into the Hartz River depression. A sheet of water about 90 square miles in extent will be produced. Paarl Municipality is embarking upon a sewage scheme to cost £140,000; Kroonstad is proceeding with a scheme for the reconstruction of its electric power system, which will comprise a new power station containing two three-phase alternators, each rated at 1250 kilowatts, together with steam-raising equipment and an economiser for 200 lb. per square inch at 600 deg. Fah.; Lydenburg is to spend £13,000 on a new water supply scheme. There is a great demand for electric cooking stoves, water heaters, and refrigerators. Cape Town is installing cookers at the average rate of 210 per month. In the Union and in Rhodesia there is a boom in wireless material; fully 50 per cent. of this business goes to American firms.

Pioneer of Steel Industry Dead.

The death occurred in Pretoria on October 23rd, of Mr. Cornelius Frederik Delfos, the only full-time director of the South African Iron and Steel Industrial Corporation, Ltd. Mr. Delfos was sixty-five years of age, and was perhaps the first man to visualise the great industrial undertaking which is now approaching completion at Pretoria West. Born in Amsterdam, Mr. Delfos was an engineer by profession. He came to South Africa forty-three years ago, and went straight to Pretoria, where he set up a small workshop with only one lathe. The enterprise grew and developed into the well-known concern, Delfos, Ltd. As early as 1906 Mr. Delfos conceived the idea of an iron and steel works at Pretoria, and spent many days on the hills overlooking the town prospecting for iron ores, coal, and limestone. His investigations convinced him of the success of such a project, both technically and economically. He was able to interest friends, who put in capital to put up an experimental plant close to the site of the works now being erected. This experimental works, the Pretoria Iron Mines, Ltd., worked successfully from 1918 and manufactured about 5000 tons of pig iron. In 1921 the name was changed to the South African Iron and Steel Corporation, Ltd. From that time until the Iron and Steel Industrial Bill was passed, Mr. Delfos made many visits to Europe endeavouring to raise capital for a large works. It was after his failure to secure capital that the Government stepped in and passed a Bill to form the present corporation.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

COMPRESSED AIR CYLINDERS.

Sir,—I am directed by my Committee to express their thanks for your report on the discussion which took place between members of this Association on "The Testing of Compressed Air Cylinders," on November 15th.

It is regretted that in the notes of the proceedings transcribed for you it was stated that the Admiralty regulations for the testing and examination were "dead." The last word of this paragraph should read "read," as, of course, the Admiralty have gone very thoroughly into this question and they lead the way about the procedure to be adopted.

J. Hope Harrison, Joint Hon. Secretary,
Diesel Engine Users Association.
307, Abbey House, Westminster, London, S.W.1,
November 29th.

THE NEWCOMEN SOCIETY.

From the twelfth annual report, covering the session 1932–33, of the Newcomen Society, we learn that during the year sixteen new members were elected. On October 1st, 1933, the membership of the Society totalled 323.

During the year under review there were eleven meetings, viz., eight in London, one a joint meeting in London with the Omnibus Society; two in New York; and the summer meeting in Cornwall.

As the outcome of a paper by Captain Smith on November 16th, on "Joshua Field's Diary of 1821," Miss Field has agreed to present Part II. of the Field Diary to the Science Library. It is gratifying to be able to record that the Shetland Water Mill, described in Messrs. Dickinson and Straker's paper, has been secured for the nation, and will shortly be exhibited in the Science Museum. Arising out of Mr. Dickinson's paper on "Joliffe and Banks, Contractors," last session, Sir Edward Banks's tomb at Chipstead, Surrey, has been restored by the chairman of the Bridge House Estates Committee of the City of London—Mr. J. J. Edwards—at his own expense. The President, on behalf of the members, on January 18th, presented to E. A. Forward a silver salver in recognition of his valuable services as Hon. Treasurer of the Society, practically since its inception.

With regard to the preservation of objects of outstanding interest, the Society supported the appeal for, and contributed to, the preservation of Sprowston Windmill, Norwich, which, unfortunately, has since been burnt down. The Society is, through local members, keeping a watch over the Iron Bridge, 1779, at Coalbrookdale. During the year under review, Extra Publication No. 3, "The Aeronautical and Miscellaneous Note Book, *circa* 1799–1826, of Sir George Cayley," was published, and the Council is open to consider suggestions for another such publication. Volume XI. of the "Transactions" was issued, and Vol. XII. is in the press.

As the majority of members are unable to attend meetings, and are, therefore, dependent on the "Transactions," the Council has been considering ways of increasing their interest by ensuring that they receive copies of publications sooner. It was decided, therefore, that Rule X. shall be taken to mean that "Every new member, when his first subscription is paid, shall receive a copy of the "Transactions" and any Extra Publications issued during the session in which his election takes place, and that as soon as his resignation is accepted or death reported, no further publications shall be sent, and that such action shall be retrospective." Consequently, ninety members have become entitled to back numbers of "Transactions," and in response to the Hon. Secretary's invitation, seventy volumes have been posted.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

INSULATING VARNISH.

No. 514—1933. This specification deals with baking varnish of the bitumen type, which gives a finished film which is flexible, moisture-resisting and capable of withstanding vibration without chipping or cracking. The varnish covered by the specification is suitable for the impregnation of coils, including those of electric traction plant, and for use in any situation where apparatus is subjected to vibration. The specification is based on the results of considerable investigations made by the British Electrical and Allied Industries Research Association, and is drafted in the usual form of clauses defining the performance limits, followed by appendices describing in detail the methods of testing to be employed.

RUBBER TUBING FOR PETROL, &c.

No. 4 F 7—1933. This is a revised specification for Rubber Tubing for Aircraft Purposes, and its scope is limited to rubber tubing for use with petrol, benzol and paraffin, the previous edition 3 F 7 having included lubricating oils. Two classes of tubing are dealt with, namely, ordinary tubing and embedded wire tubing. The sizes range from $\frac{3}{16}$in. to $1\frac{1}{2}$in. internal diameter. The standard methods for determining the strength of the canvas, the chemical analysis of the rubber compound, the permeability to petrol, the resistance to benzol, and the resistance to accelerated ageing of the finished tubing are fully described.

Railway and Road Matters.

On a recent occasion the up "Queen of Scots" Pullman train on the London and North-Eastern route left Leeds 18 min. late, but arrived punctually at King's Cross. It thus covered its non-stop journey of 186 miles in 175 min. The 156 miles from Doncaster were run in 139 min., or an average speed of 67·3 miles per hour. The load behind the tender was 295 tons and the engine was "No. 3284," an "Ivatt Atlantic," built in 1904.

Public notice has been given by the Southern Railway Company of its intention to apply to Parliament during the present session for certain powers, amongst which is authority to build a railway, 4 miles long, from a junction with the main line near Folkestone to a junction with the same line 557 yards east of Abbotscliff Tunnel. This sounds to us like a deviation railway to avoid the possibilities of the main line being obstructed by falls of cliff, as happened during the war. The London, Midland and Scottish also has given notice of a Bill. As regards new railway works it is very vague, as the notice speaks only of the "construction of railway and works in the urban district of Hazel Grove and Bramhall in the county of Cheshire."

A note in the *Electrical Review* says that the whole State railway line between Malmö and Stockholm, a distance of 599 kiloms., had been electrified by October 1st, and on December 1st electric traffic was starting on the Malmö–Trälleborg line, a distance of 31 kiloms., so that after that date the trains for the Continent will be hauled all the way from Stockholm to the south of Sweden by electric locomotives. Electrification work on other important State railway lines continues, and it is hoped that the Oerebro–Krylbo junction line (132 kiloms.) will be opened for electric traffic on October 1st, 1934. When this electrification is complete, express trains from Malmö and the Continent to Norrland towns will no longer run *viâ* Stockholm, but *viâ* Mjoelby–Hallsberg–Oerebro–Krylbo, thus saving much time.

The Railway Returns do not give the number of privately owned wagons; only of those that belong to railway companies. All the former class, before they are put into service, have, however, to be registered by the Railway Clearing House. The number of these is given in the Railway Returns, and from that source we learn that 902 were registered during 1932, as compared with 1287 in 1931 and 4774 in 1930. Those registered last year included 383 20-ton coal wagons and 453 12-ton coal wagons. The number of containers owned by British railways on December 31st, 1932, was 7027, as against 6290 in 1931; of the former, 2405 were open containers, 4610 were covered, and 12 were "roll-off." The average tonnage capacity was 3·37 tons.

Among the fatal accidents to railway servants during the March, 1933, quarter, mentioned herein on November 24th, was one to a capstanman. That unfortunate man was killed by an explosion in the pit of an electrically operated capstan. There was an accumulation of coal gas in the pit which had come from a defective pipe situated close to an electric distribution box. The gas pipes have now been moved away, and as a further, and more effective, precaution, the holes where the cables enter the cast iron boxes in which the capstans are housed have been sealed. Mr. J. L. M. Moore, the assistant inspecting officer, in reporting on the accident, says that the sealing of all holes below ground level, which lead into the pits of electric capstans, appears to be desirable, and might with advantage be made the subject of a general instruction.

As Mr. Herbert Morrison was one of the most businesslike men to fill the office of Minister of Transport, his remarks on transport command respect. It should be noted then that, speaking at York on Thursday, December 1st, on some problems of the transport industry, he said: "We would bring all railway companies and all long-distance road passenger and goods undertakings under one great national corporation, which should be a public authority running the services as a public concern and for the public advantage. It may be that canals, coastwise shipping, and ultimately air transport should also be brought in. Provision may possibly have to be made for some departmentalisation and some decentralisation, but it is important from the public point of view that transport shall be dealt with as a whole by men who are transport minded, and not by men who have merely railway, road, canal, shipping, or aircraft minds.

The collision of September 8th, at Bowling on the Glasgow–Helensburgh section of the London and North-Eastern Railway, between an express to Glasgow and four empty trucks, mentioned herein on the 15th idem., was inquired into by Lieut.-Colonel Anderson, whose report thereon has recently been issued. It appears that on the morning in question some wagons had to be transferred from sidings on the up side of the line to other sidings on the down side. The wagons were propelled by an engine on to the up main line, and should then have been drawn through a cross-over road on to the down line and propelled thence into the down siding. The shunter, however, first failed to couple all the wagons together, with the result that when the engine went through the cross-over road four wagons were left behind on the main line, and the shunter's second error was his failure to notice this. The signalman now made an error, as when the express was offered to him he did not ascertain that the line was clear, and the collision resulted. There were no serious personal injuries and surprisingly little damage to rolling stock. On the latter feature, Colonel Anderson remarks that although the engine of the express and the six bogie coaches were all derailed, there was no overturning or telescoping, and there was only one broken window in the whole train. Although track circuit would have prevented the collision, Colonel Anderson—to his credit be it said—remarks that there are many other places where equipment of this kind is, owing to worse local conditions, still more desirable; and this accident might equally have been prevented by the exercise of a very little care and obedience to rules on the part of the men principally concerned. "I therefore make no recommendation as to the provision of such apparatus."

Notes and Memoranda.

A section of a noteworthy tree has been sent to the Imperial Forestry Institute at Oxford. It was sent by the Government of Nigeria, and was cut from a mahogany tree having a girth of 60ft. at 3ft. from the ground and 42ft. at 6ft. The main stem was 154ft. high, and yet it is said that there is another even larger mahogany tree close by.

The most favourable time to apply calcium chloride to gravel roads, to preserve their moisture, is, according to Mr. B. C. Tiney, of Michigan, during the drying period just following a rain, after the surface has been bladed to proper smoothness. The moisture in the road at that time hastens dissolving and penetration. In the absence of rain, application in the early hours of the day, when the air has high relative humidity, is very desirable. Application just prior to rain should be avoided, because of the loss from washing off the road.

The Budapest radio broadcasting station, which has been equipped with a new 120-kW transmitter, has what is claimed to be the world's highest aerial mast, the highest structure in Europe and the third highest in the world. It is of steel trellis work, guyed in the middle, and is 932ft. high. To this must be added the telescopic steel pole, which can be pushed out at the top to bring the total height to 1022ft. It was built under the direction of a British firm of contractors which own the patents of the system under which it has been constructed.

Some solid steel piling which was driven in the Gulf of Mexico thirty-one years ago, and has not since been painted, was recently inspected by the Carnegie Steel Company, which rolled the original steel. It was found that the piles were covered with a scale, which, in places, was as much as 2in. thick, but the loss of metal by corrosion was nowhere more than ¼in. The piles were originally 6in. in diameter. In an account given in the *Engineering News-Record*, the composition of the piles is not disclosed, but steel in other parts of the structure is said to have the following composition:—Carbon, 0·25; manganese, 0·43; phosphorus, 0·020; sulphur, 0·029; and copper, a trace.

The possibility of the widespread use of rhodium in electro-plating was discussed at a recent meeting of the Electro-Depositors' Technical Society, when Mr. R. N. Atkinson demonstrated a process which has recently been patented. The new finish, rhodium, possesses remarkable properties. It is extremely hard, and its resistance to the attack of acids is superior to any other plating metal. As an offset to the high cost of the metal, it has been found that a very thin plating—no more than one ten-millionth of an inch—is remarkably continuous, and will resist corrosion and wear to a high degree. The plating process is rapid, taking no more than five to fifteen minutes to complete.

Commenting on the proposal of Dr. Cosyns, who collaborated with Professor Piccard in his ascent into the stratosphere, to make a similar exploration next April, *Nature* explains that the doctor's plans are to investigate, during his ascent, the energy of the total radiation of the sun, in order to determine the calorimetric intensity and the pressure of light of the sun. He will also collect, at various altitudes, samples of air for subsequent analysis. Another practical problem he has to solve is how to enable his balloon to ascend uniformly and slowly, and how to stabilise it eventually at certain heights, his reason being that taking observations during the rapid ascent of the balloon cannot be accurate enough to allow him to draw any final conclusions. Of course, once the balloon has reached the stratosphere it is almost perfectly steady.

A new film camera capable of taking 2000 pictures a second and recording time as well has been developed in the research laboratories of the Western Electric Company. During laboratory experiments recently carried out it was revealed that pieces of cracked glass from a shattered electric light bulb resembled a slowly drifting snow-flake when photographed with this high-speed camera. A flashlight produced the effect of slowly lighting a stage. In the darkened chambers of a small testing booth the wink of an eye seemed to take minutes. A golf ball, at the moment when the club struck it, appeared to be deflated to two-thirds of its original size. It is believed that the camera offers possibilities of measuring deflection and displacement and of catching the flash movements of the ejection of a shell, and the explosive action of gases in a combustion chamber.

Whatever may be the advantages of welded steel construction for other types of machinery, the machine tool designer, says *Machinery*, shows little inclination to depart from the conventional iron casting. In order to meet the more arduous conditions which modern rates of metal removal impose, however, an improvement in the quality of castings is frequently essential, and in many cases is obtained by the use of nickel cast irons, of high strength, good wearing qualities, and fine finish. For the general run of machine tool bed and frame castings, a semi-steel mixture containing nickel and chromium gives excellent results. This material, moreover, eliminates the need for chilling, so that not only is the casting operation simplified but the severe internal strains set up are largely avoided. In addition, the uniform structure of nickel irons renders ageing unnecessary, an important advantage in many cases.

There has recently been erected for the Spalding U.D.C. a 0·1 square inch flexible segmental conductor which is circular and not stranded. The work has been carried out under the supervision of Mr. F. R. C. Roberts, the Council's engineer and manager. The inventor of the conductor, Mr. A. Avis, is managing director of the Segmented Wire Corporation, which was responsible for the work. It is claimed that the use of this conductor effects a reduction of 25 per cent. in the cost of an overhead line, apart from its easing of wayleave difficulties due to the possibility of using longer spans. The same type of conductor is also being supplied to Spalding in underground cable, made by the Metropolitan Cable and Construction Company, Ltd., under licence from the Segmented Wire Corporation. We believe this is the first occasion on which this type of conductor has been so employed.

Miscellanea.

A new seam of coal has been discovered at the Denton Colliery, Cumberland.

The Brymbo Steel Works, Wrexham, are to be reopened. There should be employment there for 1500 hands.

The old paddle steamer "Caledonia," which has plied on the Clyde for over forty years, has been laid up and will probably be broken up.

Twenty-two European countries will grant special travelling facilities, representing savings of from 10 to 33 per cent., to visitors to the British Industries Fair next February.

First-class crystal graphite has, it is said, been discovered recently by a geological expedition, on the northern slopes of the Turkmenistan Mountains, near the source of the Kshernysh River.

There is some talk in America of cutting a ship canal across the upper end of the Florida peninsula. It would be 166 miles long, have a bottom width of 200ft., and a depth of 38ft. The cost is estimated at 138,000,000 dollars.

It is reported from Athens that coal has been discovered in Greece. The seam is in the district of Tamonaia, near the marble quarries of Karystos, in the south of the Island of Eubœa. The analysis is said to have shown satisfactory results.

A factory for the manufacture of ammonia sulphate is to be put up in Japan by the Mitsui Company. It is to have an output of 120,000 tons a year, will cost about £2,000,000, and will be adjacent to the atmospheric nitrogen plant at Miike.

Non-metallic minerals—other than fuels—are now produced in America to the value of approximately a thousand million dollars a year, or nearly that of all the metals combined, while this annual value is increasing at a faster rate than that for the metals.

The inhabitants of the Paotsing district of Manchukuo have petitioned the Manchukuo authorities to construct a railway from Lishuchen to Paotsing, 130 miles. They point out that the district is very fertile and that the scheme, if carried into effect, will prove profitable.

A scale model of a Loeffler high-pressure boiler is now being exhibited in operation in the Science Museum, South Kensington. The model represents the type in use in the Trebovice power station, designed for a pressure of 1900 lb. per square inch and a superheat temperature of 950 deg. Fah.

Until comparatively recent years, the sea passage to the Kara Sea was considered to be an impracticable route for navigation, but it has now been shown that this is far from being the case, and there is every indication that it is likely to assume increasing importance in connection with the import and export trade of the U.S.S.R.

The Coal Mines Reorganisation Commission has been informed by the West Yorkshire coalowners that the scheme of partial amalgamation which has been under consideration in that district for some time has broken down. It gained the support of coalowners responsible for nearly 70 per cent. of the output of the district, but the rest have refused to join.

For the purpose of transporting sixteen railway coaches, built by the Birmingham Carriage and Wagon Company, to Liverpool for shipment to Brazil, *viâ* the G.W. and L.M.S. railways, it was necessary temporarily to remove thirty signal posts, as the coaches were too wide for the English loading gauge. The journey of 90 miles occupied nineteen hours, and required a train gang of twenty men.

Coal has been discovered near the source of the Bolshaya Karachevka River, 75 kiloms. from Magnitogorsk, by the Ural Geological Investigation Committee. A shaft sunk in the Mikhailovsk settlement has revealed at a depth of 9 m. three layers of coal of a satisfactory quality from 1½ m. to 3 m. thick. According to the preliminary investigations, the coal deposits extend over a considerable area.

A Micro-chemical Club is being formed by a number of scientific workers interested in the use and improvement of micro-chemical methods, for the purpose of developing interest in the science, pooling ideas, and subscribing to certain journals. The secretary of the Club, Dr. M. Healey, Wellcome Physiological Research Laboratory, Beckenham, Kent, will be pleased to answer inquiries from anyone who is interested.

Work has just been started on the Bonneville dam on the Lower Columbia River at Grande Coulee, Washington, which is at the head of tidewater. The head available for power purposes will be 62ft., and 90,000 kW is to be developed by the first two units. There is sufficient water for from ten to twelve units. The reservoir will be about a mile wide by 50 miles long, and will be used for navigation. The cost of the works is estimated at 31,000,000 dollars.

Many engineers will hear with regret of the death of Mr. J. W. Harris, of Gloucester, on November 23rd. Mr. Harris started his engineering career with Fielding and Platt, Ltd., and in 1902 joined the staff of what was then the Universal Tube Company, Ltd., Derby-road, Chesterfield, which undertaking was later acquired for the Chesterfield Tube Company, Ltd. Except for six months spent in America, Mr. Harris remained at Chesterfield as chief engineer until 1928, when he was compelled to live in the South of England for health reasons.

In 1927, eight Babcock and Wilcox boilers were installed in the Kearsley power station of the Lancashire Electric Power Company, each for an evaporation of 75,000 lb. of steam per hour at 305 lb. per square inch, and 700 deg. Fah. final temperature. This station was fully described in our issues of July 31st and August 7th, 1931. It has recently become necessary to increase the evaporation of each unit to a normal load of 95,000 lb. of steam per hour, and in July last Babcock and Wilcox, Ltd., received an order for a Bailey water-cooled furnace to permit this increase of load. This Bailey furnace has now been in operation for some weeks, and a decision has already been reached to equip similarly the remaining seven boilers.

SOME AMERICAN VERTICAL-LIFT DRAWBRIDGES

(*For description se page 562.*)

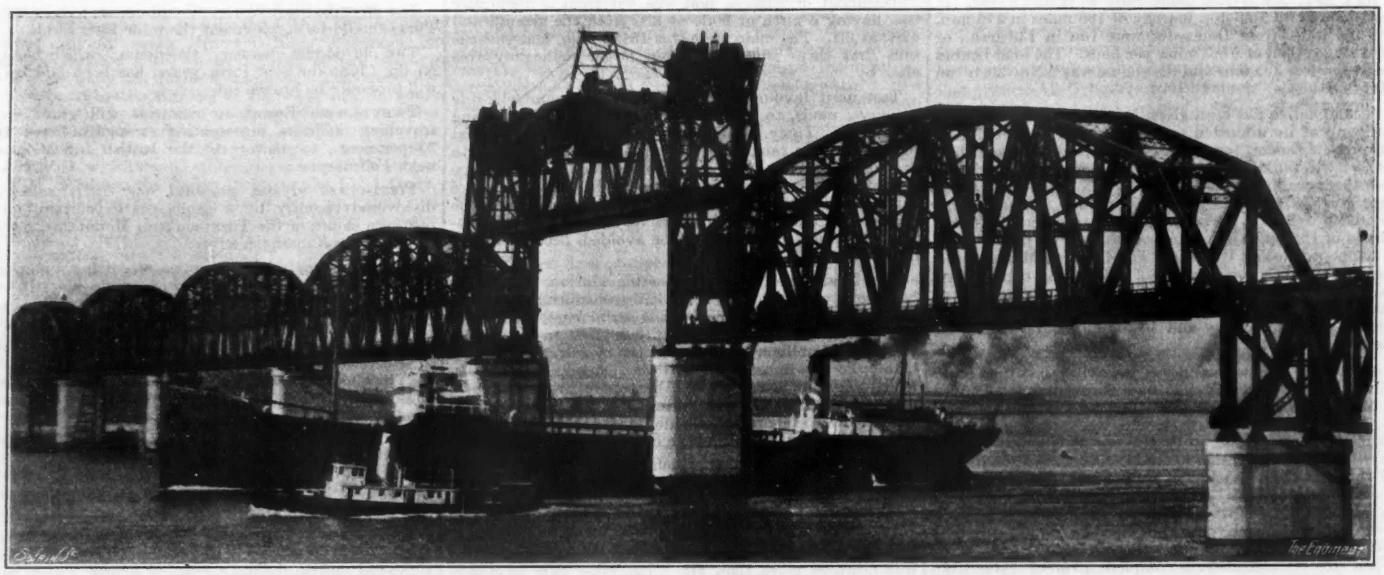

FIG. 5—LIFT SPAN OF SUISUN BAY BRIDGE—SOUTHERN PACIFIC RAILWAY

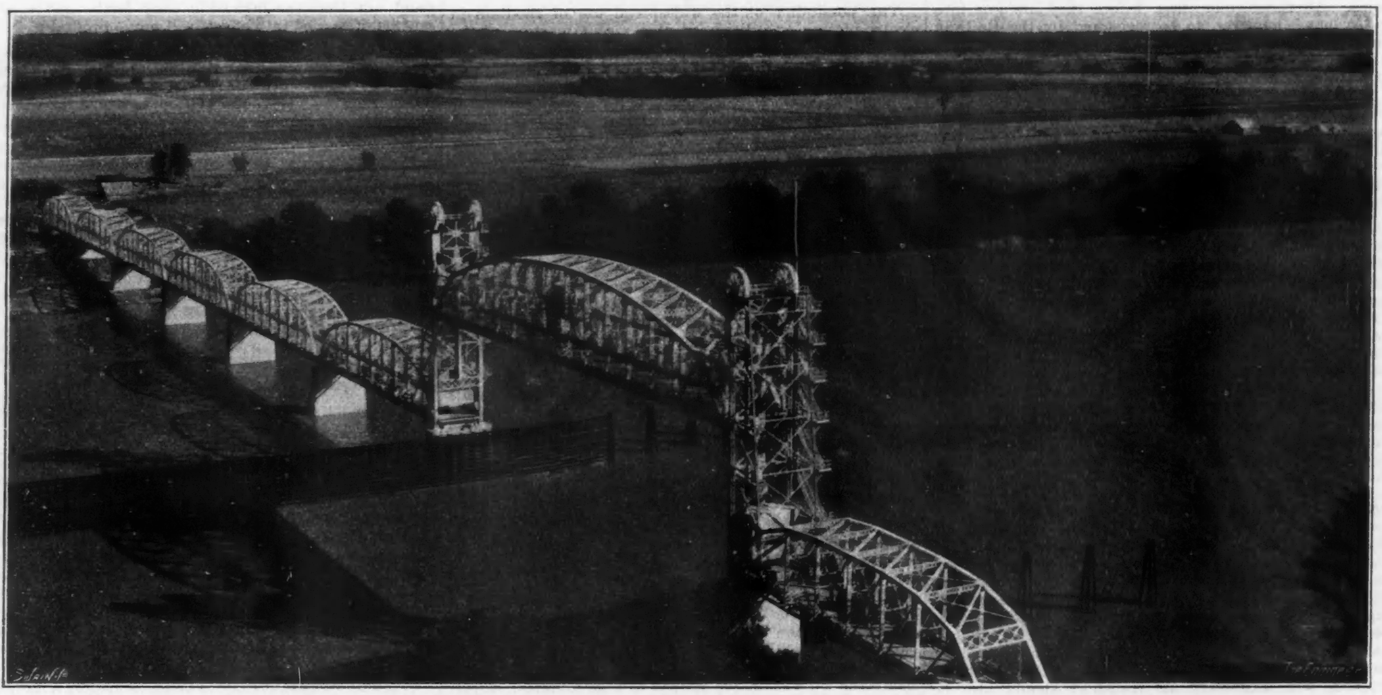

FIG. 6—ILLINOIS RIVER HIGHWAY BRIDGE AT HARDIN

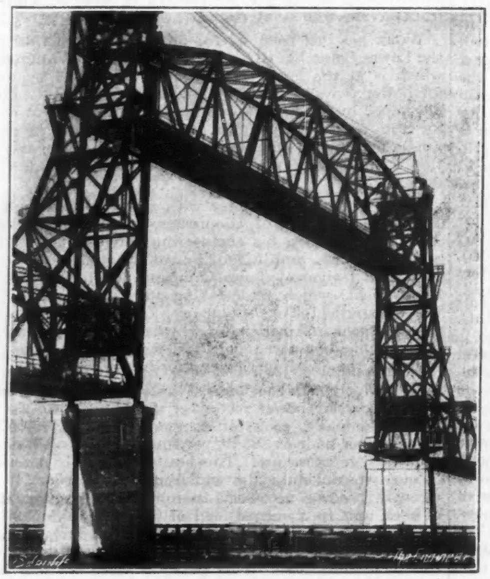

FIG. 7—LIFT SPAN OF JAMES RIVER BRIDGE

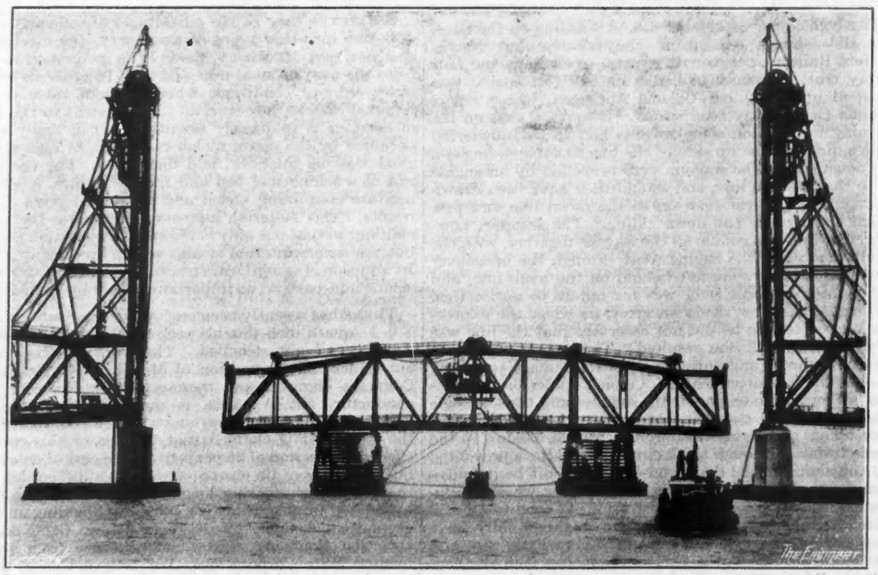

FIG. 8—PLACING THE LIFT SPAN OF THE SAN MATEO BRIDGE

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MULTIPLE MARINE OIL ENGINES.

In the sixth Thomas Lowe Gray Lecture, which is summarised in our present issue, Mr. H. R. Ricardo presents an able case for the use of really high-speed oil engines in combination with electric generators for ship propulsion. As the President of the Institution of Mechanical Engineers pointed out when introducing the lecturer on Friday evening last, probably no engineer has done more than Mr. Ricardo to further the development of the high-speed oil engine. His proposals, therefore, deserve the careful consideration of the marine engineer and naval architect, even although, at first sight, they do appear to be somewhat revolutionary in character. The idea of utilising multiple engines for an electrically propelled liner is not entirely new, for a few years ago a scheme was, to our own knowledge, planned and put forward by a leading British shipbuilding firm for a very large Atlantic liner in which a great many engines driving generators formed the propelling and auxiliary machinery. These units, were, however, fairly large power engines running at a medium speed, whereas Mr. Ricardo advocates smaller and lighter high-speed units. Although he limits the proposed use of oil engines to ships of not more than 6000 B.H.P., we cannot agree with his suggestion that a case cannot without difficulty be made out for the use of oil engines in really large and fast vessels. In this connection it is worthy of mention that two of our most successful Atlantic liners are motor ships of close upon 27,000 gross tons, and are propelled by 8500 B.H.P. engines, and that several motor vessels recently ordered for Australia, New Zealand, and other services, have machinery considerably more powerful than the limit of 6000 S.H.P. Mr. Ricardo postulates. This self-imposed limitation does not affect in any way the proposals he puts forward, which, however, if they are to be attractive, must be framed to appeal to the shipowner on the essential grounds of first cost, weight and space, and operating and maintenance costs.

Remembering, perhaps, R. L. Stevenson's advice to essayists, Mr. Ricardo missed no opportunity of vivifying his lecture and in consequence, some of his figures and points are meant to be more effective than precise. For example, his figure of no more than 4000 hours at sea per annum is scarcely typical of modern motor ship practice, for which yearly duties of 200, 250, and, in special cases, up to 300 days at sea are on record. Again, Mr. Ricardo is not quite correct in his assumption that the marine oil engine develops no more than two-thirds of its maximum power at sea. There are many instances in which the machinery is called upon to operate, and does operate successfully, at outputs close upon, and even higher than, the trial trip performance. It must, however, be conceded to Mr. Ricardo that the marine oil engine has, as he claims, if anything a lighter duty to perform than an engine operating under road or rail transport conditions. As to his estimate of the cost of engines, we fear the possibility of manufacturing high-speed oil engines at £2 10s. or £2 per horse-power is at the present somewhat remote. Colonel Fell, in a paper on compression-ignition engines for railway service, read before the Institution of Mechanical Engineers about a year ago, gave a figure of £2 10s. for the oil engine unit, and, incidentally, £8 for the electric-traction equipment. That oil engine figure was much criticised at the time, and the present price of an engine is nearer £4 to £5 per horse-power, to which must be added, say, at least a further £5 per horse-power for electrical equipment, including propelling motor and switchgear. This gives £9 to £10 total, which compares with about £6 per horse-power for slow-speed oil engines of modern design. Indeed, when the high cost of the electrical equipment is taken into account, we fear it will be difficult to present an attractive case for Mr. Ricardo's scheme on engine cost. On the other hand, there are undoubtedly considerable advantages in his proposal in the equally important matters of weight and space. Although he gives a weight of about 1½ tons for each of the seventy-five generating and auxiliary units, making a total of over 112 tons, he presents no particulars of either switchgear, the propelling motor, or the auxiliary pump weights, all of which will add considerably to the weight of the total installation and probably make it heavier than a direct driven machinery arrangement. With regard to space, however, it may be noted that with a beam of 60ft., an engine-room length of only 27ft. 6in. is required by Mr. Ricardo, which compares with an engine-room length of about 60ft. for engines of normal design. It is also probable that there will be some saving in the space required for auxiliaries and uptakes. Further savings, we may suggest, might be made if high-speed multiple propellers were to be employed instead of a single large motor and its propeller. With regard to operating and maintenance costs, some interesting figures are put forward by the lecturer, but again they must be set against results which are being obtained in modern motor vessels. In a Doxford-engined ship which was quite recently completed, the total fuel consumption for the main engine—which drives most of its auxiliaries—is only 0·36 lb. per B.H.P.-hour, a figure which the high-speed oil engine will find it difficult to rival or surpass. It would also seem true that the consumption of lubricating oil for the few cylinders of a large, slow-speed engine would be considerably less than for the hundreds of cylinders of the small high-speed oil engines, for which Mr. Ricardo assumes, we note, a flow of about 200 gallons per minute. These are factors which need to be considered in fuller detail. The repair costs mentioned by Mr. Ricardo are very high when it is remembered that liners and main running parts in a modern oil engine will run for four years at full power, and a further two years when de-rated without needing serious repairs which may be generally taken not to exceed per annum 1 or 2 per cent. of the engine cost. The higher cost of high-speed engine repairs may be partly explained by the reason that when running at 1600 to 2000 r.p.m., the fatigue limit of piston rings, valve springs, anti-friction metal bearings and other wearing parts is reached earlier than would be the case with a slow-speed engine running at 90 to 100 r.p.m. But "the proof of the pudding is in the eating," and we venture to suggest that Mr. Ricardo, in collaboration with an electrical engineer and a naval architect, should work out more fully his interesting proposals for three different ships—a fast Thames passenger vessel, a large cross-Channel motor ship, and a cruising liner, of, say, 10,000 tons. A paper based on that examination might well be presented and discussed at the spring meeting of the Institution of Naval Architects. The locked engine cell is familiar in the naval pinnace and motor cruiser, but it could quite well and properly be extended to meet the needs of a fast-running fleet of passenger vessels plying on the Thames. We commend this suggestion to the London Passenger Transport Board, which, in collaboration with the Associated Equipment Company, Ltd., has built up such a valuable amount of experience in the operation of high-speed oil engines in road service. That experience could at once be applied to river traffic if suitable designs were forthcoming. For the cross-Channel vessel we venture to suggest that the Southern Railway Company, which has done such pioneer work in electric railway traction, might be persuaded to look with favour on the design of a large, electrically propelled motor ship for cross-Channel service which could be fully stabilised and should then prove a very popular ship. It is well known, too, that, despite the recognised success of summer and winter cruises we have in our British mercantile fleet no single class liner specially designed for this work. Such a machinery arrangement as described by Mr. Ricardo might be worked out with advantage for this special class of ship. If one or more of these vessels were to be built, then the dream of Mr. Ricardo—we believe it to be a dream and not a nightmare, as he himself half fears—would become a prophecy, and what he ardently desires—the furthering of British enterprise and marine engineering prestige—would be achieved.

We offer these criticisms not in a spirit of conservative opposition, but because the lecture was provocative as Mr. Ricardo meant it to be. New ideas, emanating from men of well-established reputation, are to be welcomed in every branch of engineering. It is so fatally easy to get into ruts which, as the years pass, grow deeper and deeper, till we are unable to peer over their edges. Every now and then some more daring than the rest stand on tiptoe and get a peep of a wider horizon. Opposition to their proposals there is bound to be, because the conditions which favour existing designs have, to a great extent, grown up with those designs, and it is, therefore, always easy to prove that what is is best. But every engineer should welcome excursions of a lively fancy, especially when they are made by men who have established their right to speak and present their case with technical knowledge. Mr. Ricardo's lecture will be a source of debate for months to come, and we may yet see his vision realised. More wonderful things have happened.

Parity in the Air.

Ten years ago Mr. Baldwin made an official declaration of his Government's policy concerning the aerial strength of this country. After meeting the essential air requirements of the Navy, the Army, India, and other overseas commitments, Great Britain, it was laid down, should possess an Air Force strong enough to protect her against attack from any air force within striking distance of her shores. Succeeding Governments have not openly discarded that policy, but from its initiation it has never been more than a guiding principle. Deliberately and without secrecy this country's air strength has been cut down, and kept down. It was fondly hoped that the standard envisaged in 1923 would be reached, not by Great Britain increasing her aerial strength, but by other nations following her example and reducing theirs. Willingly this country would have gone so far as the complete abolition of all naval and military aviation—subject only to a satisfactory system of international control being devised effectively to prevent the misuse of civil machines for war purposes. These aspirations and efforts towards total or partial aerial disarmament received little or no support abroad. As a consequence, this country now finds itself fifth—or possibly sixth—in the order of the world's air powers as judged by the number of machines possessed. We are to-day, it is asserted, at least ten squadrons—or, say, a hundred effective machines—short of the minimum deemed necessary for home defence. To cover the whole of our requirements at home and abroad we have approximately 850 first-line machines. Of these machines, it is understood that about 490 are stationed in Great Britain, the rest being in India, Egypt, Palestine, and elsewhere overseas. The French Air Force has about 1650 first-line machines. The Soviet Republic owns, it is believed, between 1300 and 1500. Italy and the United States possess something over 1000 each. The aerial strength of Japan is not known with any assurance, but is undoubtedly of a high order. Facing the realities of the position, the Government has now determined that our present relative weakness in the air cannot be allowed to continue. On Wednesday of last week, simultaneous statements on the subject were made in the House of Lords and the

House of Commons by Lord Londonderry, the Secretary for Air, and by Mr. Baldwin. By one means or another the Government is now determined to secure parity in the air with any other single Power. If other nations will not come down to our level we are to build up to theirs.

That this country is in a position to make itself as strong in the air as the strongest there cannot be a shadow of doubt. The British aeronautical industry, thanks largely to the enlightened policy of the Air Ministry, is, in all its aspects, highly organised, strongly established, and efficient. It is capable of supplying and does supply the Royal Air Force with all the machines, engines, instruments, and military equipment which it requires, and in addition contributes in no small measure to the material requirements of certain other nations' air forces. Its organisation and its present position are certainly such that it could quickly respond to a greatly increased demand for machines. As regards its capacity to develop on the technical side and to remain in the van of progress, we have the knowledge that behind it there is a large and able body of investigators, Government and private, liberally equipped to carry out their important duties and in full and harmonious contact with the manufacturing side. Incidentally, the revolution effected since the end of the war, by which the use of wood for major purposes has been abandoned in favour of steel and light alloys, has freed the industry from dependence in any way upon imported supplies of materials. We can, then, rest assured that the building up of Britain's air strength to parity with that of any other nation—and doubtlessly to something more than parity if it were desired—is well within the compass of what the British aeronautical industry is to-day capable of achieving. However parity may be defined, whether it be regarded simply as synonymous with numerical equality or be judged on a more comprehensive basis, this country has the power to realise it. It must not, however, be overlooked that the Government's policy is not intended in any way to be aggressive, and that aerial disarmament, partial or complete, is still earnestly desired. A foolish and wasteful era of competition among the nations of the world for aerial supremacy is the last thing which the Government or anyone else desires to see. Efforts to secure aerial disarmament will be continued, but they will now be made in a new, and, it is to be hoped, a more salutary atmosphere. Unarmed among armed nations, this country, as Lord Londonderry said, cannot speak with authority. British weakness in the air, conditions being as they are, is a menace to peace. "The armed strength of Great Britain has invariably been thrown into the scales upon the side of peace, and there could be no greater encouragement to the aggressive policy of any nation than the knowledge that the sword of Britain is no longer heavy enough to tip the scale against aggression." In these words the Secretary for Air sums up the true implications of this country's new air policy. That that policy may be misunderstood or misinterpreted abroad is distinctly possible. That patience and diplomacy and more than a little skill will be required to guide it to the desired end and not to one diametrically opposite to that intended is certain. The difficulties of the situation are patent, but it cannot be doubted that they are less than those in which the continuation of the one-sided disarmament policy of the past ten years would at no distant date have involved us. The old method having failed, the same object is to be sought from the opposite direction. The reversal of the mode of attack inevitably involves risk, but it substitutes for a negative policy based on hope an active one founded on realities.

In discussing this subject one cannot fail to perceive that it has many issues and many points of contact with other aspects of international affairs. What, for instance, is applicable to the air is, with certain changes, applicable to the Navy and the Army and their equipment. It is doubtlessly because of this fact that Mr. Baldwin, in the course of his remarks last week, introduced a short but important passage in which he indicated that it was the Government's intention to consider the three Services together and to repair their deficiencies as a whole. Again it would be folly to ignore the bearing which our new policy in the air must have on the problems presented by Germany's demand for equality in armaments. If we are persuaded that parity for us is essential for the preservation of peace, can we resist a similar argument advanced on Germany's behalf? Confining ourselves, however, to the strictly aeronautical aspects of the subject, we find in the new policy and the situation which has forced it upon us two outstanding factors which demand careful consideration. First, it is clear that the new policy leaves the problem of the international control of civil aviation as acute as, if not more acute than, before. Parity with respect to military and naval aeronautical equipment will be an illusion and a dangerous deceit if the nations are to be allowed unrestricted freedom to build and operate civil machines capable of being converted at short notice for war purposes. Secondly, if our determination to secure parity is, as intended, to be an influence working towards peace and not a factor promoting international discord, it will be necessary to make it clear from the outset what is meant by parity, whether merely the number of machines possessed is to be taken into account or whether in its assessment allowance is to be made for their quality and equipment, their geographical distribution, and the facilities possessed for their replacement and multiplication in a time of emergency. Each country may reasonably claim to be the best judge of what constitutes parity in its own case. If, however, the principle of parity is to prove a source of international harmony and not of continued disagreement, if it is to create a sense of security and not distrust, an internationally agreed meaning must be sought.

The Road Accidents Report.

A MONTH ago, in a leading article entitled "Road Accidents," we stressed the desirability, before any legislative action was taken, of collecting together all the available data with regard to such accidents. By the analysis of these data we contended that the underlying causes of accidents might be discovered and that legislators would then be in possession of facts rather than opinions on which to base any action that seemed desirable. We mentioned that we believed some such collection of statistics was being made. The issue by the Ministry of Transport of a Preliminary Report on Fatal Road Accidents, which is concerned with the period of six months ending on June 30th last, indicates that the matter is being taken seriously in hand. This report will, presumably, be followed by others analysing the figures to a greater extent, and taking into account also the non-fatal accidents. Although valuable in the sense that they give a general impression of the complexity of the field to be covered, the tables included in the report in their present form give but little information upon which any action might be taken. Certain misconceptions can be held to be definitely disproved, however. For instance, only 133 drivers out of 4041 involved in fatal accidents had had previous convictions for dangerous or careless driving, so that the "road hog" cannot be held mainly responsible for accidents. In fact, the impression conveyed by the report is that the majority of drivers involved in fatal accidents are quite undistinguished in any respect from their more fortunate fellows. More than half of the deaths occurred among pedestrians; and cyclists, both motor and pedal, together accounted for more than another third. While such figures have a melancholy interest for everyone, whatever his profession, trade, or vocation, they are useless to the engineer who hopes by his own efforts to do something to bring about a reduction in the toll of the road. The mechanical engineer, it is true, can gain some satisfaction from the very small proportion of vehicles in which mechanical failure of any part was either the main or a contributory cause of the accident. But as as far the road engineer is concerned, the report is disappointing. He will find little guidance in it, but may derive satisfaction from the fact that in only 237 cases out of 4253 was any defect in the road held responsible as the main or contributory cause of the accident. Amongst drivers, however, this figure has already been criticised as suspiciously small, as the general expectation was that the state or configuration of the road would be found as a contributory cause in a by no means negligible number of accidents.

Literature.

The Unemployed Man: A Social Study. By E Wight Bakke, Ph.D. London: Nisbet and Co., Ltd. 1933. Price 10s. 6d.

The author of this book on unemployment in England is the Director of Unemployment Studies in the Institute of Human Relations in Yale University. With the help of a Sterling Fellowship from his University he came to this country in 1931 to gather information for a thesis on this question: "What has been the effect of unemployment insurance on the willingness and ability of workers to support themselves?" He began with the intention of pursuing his research in the ordinary economic way through blue books and white papers. He meant to analyse studies which had been made and statistics which had been gathered. But he found that "there were no studies and no statistics." So he betook himself to the Ministry of Labour to seek help in the formulation of Sample Inquiries; from which it will be seen that he proposed to do just what any other economics research worker might have done. Fortunately, he was deflected from that dull course. Mr. John Hilton, at the Ministry, put a new idea into his head: "to take lodgings with a working-class family, to share their life in so far as it was possible to do so, to join in their activities or loaf on the streets or at factory gates as the occasion might require, to go with them to clubs and churches and 'pubs,' to join the hunt for a job, and during the whole process find out all I could of the causes and consequences and adjustments involved in unemployment among the men and women who were unemployed."

It was a good idea, and Dr. Bakke carried it through well. It must have been difficult at times to get into touch, into sympathy, with the loafers whom he joined at street corners and public houses. But he managed it, and in consequence we have a book which looks at one of the greatest problems of the day, not from the standpoint of the detached scientific worker, but intimately from the inside. The author shows us how his out-of-work companions spent their time, and he increases our respect for them at the same time that he makes us admire the tact and persistency with which he stuck to a delicate task.

His field of operations was Greenwich. He may regret now that he did not go into the heart of one of the great industrial cities—to Glasgow, Manchester, Sheffield, and Birmingham. It is probable that he would have found there a different type of unemployed man from that which hangs upon the fringes of the Metropolis. But, having decided to work within the County of London, he could not have done better than settle at Greenwich, a long narrow borough "self-contained to an unusual degree and little influenced by special factors of population, social conditions, or employment." His experiences opened in a working-men's club, and were carried on in all sorts of surroundings. He appears to have got into real intimacy with men and women, both employed and unemployed, and is able to show us a good deal of their real reactions to the influences around them. The suspicion must inevitably arise that his "subjects," knowing what he was about, played up to him. We do not think that, in fact, they did so. The simple background of their thoughts which he reflects has struck many observers, and can be confirmed by all who, like engineers, have worked for years shoulder to shoulder with British workmen. Of course, there are exceptions—some of them, we suspect on the surface rather than deep-seated—but Dr. Bakke's observation that "the normal tendency of workers to look towards a readjustment of income within their class as a remedy for their unfavourable position, rather than towards a redistribution of wealth in which that now going to another class would come to them," may be taken as truly representative of the attitude of workers as a whole, at any rate in southern counties.

One of the forces that plays continually upon the working-class man "is the impression that his destinies are controlled by beings outside his ken." This feeling of control has important consequences. "It causes the worker," says Dr. Bakke, "to feel a minimum of responsibility for his own fate; for responsibility goes with control. No one who has not shared the life of the worker can realise the number of points at which the ultimate decision as to his way of life rests with others. Habit breeds attitudes. When so much of your life is ordered by others, why pretend to be able to do anything yourself with the rest?" It sounds deplorable; rather degrading—as if our workpeople were losing all their individuality. But an unbalanced view of it must be avoided. Where many men have to work together for a common purpose, a measure of mass control is inevitable, and, furthermore, it may be safely said that the control under the present system is pure liberty compared to the control which would be exercised in a Utopian State. Let us quote again: "The fact that certain people habitually control has, in the minds of numerous workmen, created the feeling that special qualifications are required for that function. This feeling may even extend to distrust of his own class on the part of the worker. . . .

Dogmatic and relentless class loyalty among the workers with whom I lived is a myth. The most intelligent denunciation, the most ironic criticisms of labour leaders, industrial and political, came not from professional and business men, nor yet from Communists, but from comfortably situated skilled and semi-skilled workmen. At times this faith in the adequacy of the 'masters' approached very close to reverence for their powers." And why not? If soldiers in the field, or sailors on their ships, may reverence the ability of the Napoleons or Nelsons who lead them, why not the workers in some great industry? In the old days, before great amalgamations had weakened the personal touch, and to this day in many a factory, the devotion to the employer and the pride in his achievements and the achievements of his works, was, and still is, one of the most important factors in the maintenance of our industries in peace and prosperity. "I could find," writes our author, "no sign of the hatred of one class for the other, the inevitable gulf between the classes, which is often asserted to exist in England as in other countries. . . . The soil among the British workers is not prepared for the sowing of Communist seed." Whilst our experience prepared us for that conclusion, it is, nevertheless, reassuring to have it from an investigator who has studied the mind of the British workmen with the care shown by Dr. Bakke.

We might turn over every page of this volume and find some comment to make on each, or some shrewd observation to quote, but we hope we have said enough to make all those who take a genuine interest in the great economic problem of the day desire to read it. We shall, however, be expected to say something of the conclusions to which Dr. Bakke's "research" brought him. These he summarises, categorically, in his final chapter, and following him we may present them very briefly under his own headings.

The first is the "Workers' Estimate of Unemployment Insurance." He tells us that, almost without exception they are in favour of some form of insurance, but have "complete lack of confidence in the exchanges as placing agencies." "Without question, the most severe criticism of unemployment insurance, favourable and unfavourable, came from the workers themselves. Their understanding of the situation was based on first-hand experience." The second heading is "Effects of Unemployment Insurance," and must be taken with the third, which is "Security *versus* Fear." In the first, Dr. Bakke rapidly sketches the manifest advantages of unemployment insurance, but observes that "it has not relieved and cannot by its very nature relieve the mental and moral fatigue and discouragement which result from having no job. It cannot supply the loss of status and the sense of self-respect which vanish with the job." Yet it saves them from utter degradation. "The sum, small as it is, . . . means the difference between giving up and keeping on as a self-respecting individual." In the second of the two sections named, Dr. Bakke challenges the view of those who aver that a constant fear of being down and out is a spur to endeavour. "In cases where fear would not be demoralising," he says, "it is not necessary or useful. In cases where it might be supposed to be useful or necessary, it is demoralising." He writes from a warm heart on this subject, but we doubt if it can be easily dismissed. It is not only in the working classes that a fear of being "down and out" exists. It is just as strong in other classes of society, and there can be little doubt that, on the whole, it has a stabilising influence which is generally for the good. When the security of the "dole"—we use the word only because of its convenience—tempts men to throw up jobs they have, or at any rate not endeavour to retain them, it is misused. One of the great troubles with unemployment insurance is that it falls alike upon the worthy and the unworthy. How to preserve its merits so that it has all the good effects upon which our author dwells, and to get rid of its defects, is a problem which so far economists and humanitarians have failed to solve completely.

This brings us to the next division of Dr. Bakke's conclusion, "Effect on Willingness to Work." Here he writes: "A great deal of confusion is caused by the application by one group of society of its own standards to the behaviour of a different group." The middle-class man has no right to assume that the incentives which actuate him will also actuate a working-class man. "Comparatively speaking, the group from which this man [the workman] came never possessed the degree of incentive assumed by middle-class individuals to be present. . . . The practical control of the worker's destiny from beyond himself and his own group has left him with a minimum of responsibility for his own fate and the feeling that it is up to the masters to do something about it." We are afraid that there is a good deal of truth in that statement. And we are still more afraid that the emotion which it records is spreading upwards. If the workman expects his employer "to do something about it," the middle-class man is now given to demanding that "the State should do something about it." In neither sphere of society is it an attitude which should be encouraged. Dr. Bakke's observation, drawn from life, is no doubt accurate, but, we would ask him, Ought not every effort to be made to resuscitate or to generate a feeling of independent responsibility in the working, as in all classes of society?

In the next section of his summary, Dr. Bakke deals with skilled and unskilled workers. He stresses the opinion that, for various causes which he enumerates, there is a sharp social and psychological difference between the skilled and the unskilled. "Project," he says, "a social policy into the world of skilled or even semi-skilled workers, and it will have one effect; into the world of the unskilled, and it will have quite another effect." Yet he found the sense of self-support so strong in all groups of both classes that, despite one or two examples, he is unable to say definitely that the unskilled class is more ready to rely on unemployment insurance than the skilled. That is so contrary to the general belief that note should be taken of it. It is not impossible that the current belief is based on the *a priori* reasoning that the better the social position, the greater the dislike to dependence on external help. Again, it is not unlikely that the middle class has judged the working class as it would judge itself, and has reached the conclusion that the nearer a workman approaches to the middle class, the more diffident will he be about the acceptance of outside help. If, however, the question is approached from the attitude of the insured person who claims that the money is his by right—that he has insured himself—then it is clear that whether one holding that view is skilled or unskilled will make no difference—in neither case will he feel any disgrace in accepting what he regards as his own.

Passing over a short section on Activities When Unemployed, we turn to one on Pauperisation, a subject not far removed from that we have just discussed. "Does or does not unemployment insurance produce paupers?" our author asks. "Does it decrease or increase the desire for self-support? I have briefly drawn together above the evidence from the specific items of study, such as the effect on the search for work, the effect on subsidiary employment, the effect on independent effort and the effect on moving between communities and industries. Furthermore, I have tried to picture the condition of life under which the workers of Greenwich make their living, build their homes, spend their leisure, satisfy their religious impulses, and take part in community activities. I have attempted to present an objective account of the satisfactions and attitudes which grow up in the midst of these conditions. *This general conclusion stands out: Unemployment insurance has not made paupers. It may have revealed some of them and supported them.*" The italics are the author's. Here, once more, the opinion of Dr. Bakke, as an intimate observer, must be respected, even when it opposes a view supported by not a few examples. The risk always exists that examples when they support an hypothesis which seems to stand to reason may be misleading. They are always dangerous, and a general impression may in favourable circumstances be more truly representative. It is that which Dr. Bakke appears to give us.

Indeed, the whole value of this remarkable work turns upon the author's strict impartiality. Whilst one should, as we have said, always suspect examples, generalities are equally dangerous, unless we can be quite sure of the *bona fides* of the person who makes them. Can we be sure of them in this case? Did Dr. Bakke enter upon his research with no preconceptions, with no desire to prove one case rather than another? Did he maintain throughout the detachment of an assessor, or was he moved by his intimacy with the unemployed to a sympathy with them which may have distorted his judgment? We cannot say. We do not know how long he spent in Greenwich, and how genuine his intimacy with the workers and loafers was. What we do know is that he presents his case with a shrewdness of observation which is itself convincing, and that he offers arguments which find their mark. It is concerning his deductions from his observations and arguments that there may be differences of opinion. They will not alter the fact that here is a book which none who are interested in one of the great social problems of the day should fail to read.

Neon Tube Practice. By Dr. W. L. Schallreuter. London: Blandford Press, Ltd. Price 10s. 6d.

Neon tube lighting for advertising has made such rapid progress within recent years that the manufacture and handling of luminous discharge tubes must now be a subject in which many people are interested. As far as we are aware, however, this is the first book of its kind published in this country. Electrical engineers and particularly those specialising in lighting should find the volume of considerable interest and assistance, for although the theoretical side of the subject has not been neglected, the author has adhered mainly to practical considerations. The physical and electrical conditions of a gas are explained in a more or less popular way, and considerations relating to the structure of the atom and other purely scientific theories are avoided. Readers who have hitherto given little or no attention to the subject will find nothing in the volume to trouble them. The author's long association with the manufacture and application of neon tubes has enabled him to throw much light on the difficulties that have been experienced in their development and on problems that still await solution, such as that of providing a wider range of colours.

In an appendix to the volume there is an interesting review of patent literature in which it is shown that a great number of improvements on the earlier tubes are protected. It also is shown that the present manufacturing methods, although giving satisfactory results, have by no means reached perfection, and are not so complete as other similar processes employed, for instance, in the valve and lamp industries. The next step in this direction, it is explained, will be to render the pumping of the tubes independent of personal attention, a problem which at the moment is not completely solved. The high-tension installation is said to continue to give rise to a great number of difficulties and its reliability still leaves something to be desired.

The study of the artistic side of this new means of advertising is considered to be in its infancy. Neon signs of to-day, Dr. Schallreuter contends, bear no relation to the architectural features of the building, and architects are far from being fully acquainted with the essential requirements and special possibilities of tubular lighting Representative chapter headings are the Gas as a Conductor, the Rare Gases, Electrodes, the Positive Column, the Electrical Supply, Air Pumps and Vacuum Technique, Glass Bending, Pumping and Filling, Ageing and Testing, the Practical Use of the Neon, the Erection of a Neon Sign, Hot Cathodes, and Low-tension Neon Tubes.

BOOKS RECEIVED.

Air Transport Manual. London: The Temple Press, Ltd., 5–15, Rosebery-avenue, E.C.1. Price 3s. 6d. net.

Théorie générale du coup de bélier. By C. Jaeger. Paris: Dunod, 92, Rue Bonaparte (6c), France. Price 86f. net.

Analytical Judgment Accounts. By W. R. Dunlop. London: W. R. Dunlop, 57, Gordon-square, W.C.1. Price 3s. 6d. net.

Trade Depression and the Way Out. By R. G. Hawtre. London: Longmans Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 7s. 6d. net.

Azimuth Determination. By E. F. Coddington. Ohio: Engineering Experiment Station, Ohio State University, Columbus, U.S.A. Price 50 cents net.

Motorships of the World. Edited by A. C. Hardy. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street, S.E.1. Price 15s. net.

Standard Methods of Analysis of Iron, Steel, and Ferro Alloys. Sheffield: The United Steel Companies, Ltd., 17, Westbourne-road. Price 4s. 6d. net.

Technique of Modern Welding. By Professor P. Bardtke. Translated by H. Kennedy, B.A. London: Blackie and Son, Ltd., 50, Old Bailey, E.C.4. Price 15s. net.

Conjugate Functions for Engineers. By Miles Walker, M.A., &c. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 12s. 6d. net.

Warmetechnische Arbeitmappe. Gesammelte Arbeitblätter aus den letzten Jahrgängen von "Archiv für Wärmewirtschaft und Dampfkesselwesen." Berlin: V.D.I.-Verlag G.m.b.H., Dorotheenstrasse 40, N.W.7. Price 4.80 marks net.

SIXTY YEARS AGO.

At least one British railway protects itself against claims for damages arising from unpunctuality of its trains by announcing in its general regulations that the published times of departure are not those at which the trains will start, but those before which they will not start. It is doubtful whether an action under this head would to-day have a greater chance of succeeding than, say, one in which damages were claimed against a medical practitioner for professional incompetence. It was not, however, always so. In our issue of December 12th, 1873, for example, we commended to the attention of British railway travellers the successful action for damages for delay in the performance of a journey brought by a passenger against the Belgian State Railways. The train had been delayed for three-quarters of an hour near Charleroi as a consequence of the line being blocked by goods wagons. The traveller sought 300f as damages for the delay to which he had been exposed. The railways resisted the demand, contending that the delay was the result of inevitable accident, and that in any event no compensation greater than the amount of fare paid could be claimed. The Court overruled the railways on the second-named point. As regarded the first, it found that the blocking of the line by an accumulation of trains constituted a fault on the part of the administration, and that the administration was bound to assure a free passage and the punctual arrival of the trains under its control. It awarded the plaintiff 150f. as damages. In another paragraph in the same issue we read that a Railway Travellers' Protection Society had been established recently in this country with the prime object of securing safety, punctuality, and comfort in railway travelling, and to receive and investigate complaints against railway companies under these and other heads. In yet another paragraph we find a side light on one cause of unpunctuality then prevailing on British railways. A memorial signed by 650 enginemen had, we read, been addressed to the Board of the North-Eastern Railway in which a plea was made for the better working of the block signals. The men complained that the auxiliary or distant signal was not operated when a train was required to stop, and that at many stations and block cabins they could not see the home signal until they were within a short distance of it. They also complained that the auxiliary wires were kept so slack that they would not raise the signals in a manner which permitted them to be understood. The enginemen suggested that if these defects could not be altered, the running time of the trains should be increased sufficiently to enable them to stop at all cabins to ascertain if the line were clear.

The "Jiges" Steam Boiler.

By Dipl.-Ingenieur E. PRAETORIUS, Berlin-Zehlendorf.

General Description.

THE Jiges boiler here described was invented and designed in 1925 by a well-known Swedish boiler engineer, Mr. J. G. Sandwall, and is patented in sixteen different countries. The name " Jiges " is only a registered designation, formed by Mr. Sandwall's initials, J. G. S. It is a water-tube steam boiler of the sectional type, with a number of water-filled straight tubes inclined at 15 deg. to 20 deg. to the horizontal forming the principal heating surface, and so far it resembles many other water-tube boilers.

The way in which the front and rear ends of such tubes in water-tube boilers in general are mutually united for co-operation, and connected with the steam drums, differs widely in different types and determines the properties of the boilers in regard to capacity, safety and economy. In boilers of the Babcock and Wilcox type, the water tubes in the tube bundle are arranged in vertical groups or sections, each such section consisting of a number of tubes connected at each end to vertical headers, which at their upper ends are united with the common steam drum or drums.

In the Jiges boiler the tube bundle is subdivided into horizontal groups or sections, all tubes belonging to one and the same section being placed beside each other and connected at each end to horizontally placed headers—one in front and one, situated on a lower level, in the rear. These headers are made of straight solid drawn square tubes, subsequently bent at the middle into a blunt V, so that each half of each header forms an angle to the horizontal of 15 deg. to 20 deg., or the same inclination as that of the water tubes themselves, in order to make the water circulation through the whole system as even and lively as possible.

From each end of these headers run tubes connecting the headers with the steam drum above. Through the tubes at the front end (the " risers ") the steam produced enters into the steam drum, while through the rear tubes (the " downcomers ") the water is fed from the drum to the section.

The diagram, Fig. 1, shows in full lines one such complete section consisting of water tubes, front and back headers, risers, downcomers, and their connection to the drum. Dotted lines indicate how a number of such sections may be piled up on each other, and how they are coupled to the steam drum. Each such section forms a small closed boiler in itself, with independent steam delivery to, and independent water supply from, the drum above, and boilers of any desirable size can be built up by combining a suitable number of such sections of proper size into a complete unit.

The connecting tubes—risers and downcomers—form a part of the total heating surface, and it is evident that in the way they are formed they admit the headers of each section to move freely without straining any joints, thus making the whole boiler system elastic. It is also evident that as all the straight water tubes belonging to one section lie practically in the same heat zone, they all expand and contract alike, and that as the headers can move freely all additional strain in the tube joints is completely avoided and perfect tightness, even by sudden changes in temperature, is insured.

Furthermore, since all the tubes of one and the same section are alike and exposed to practically the same temperature, the steam-producing conditions must be the same in them all; that is to say, the steam production, quality of steam, and speed of flow, &c., must be practically the same in all these tubes. The steam-water emulsion from each section being of the same quality, is discharged directly into the steam drum above without mixing or interfering with that from other sections, thus differing radically from the conditions in boilers with vertical sections. Fig. 2 shows a Jiges boiler with 450 square metres=about 4800 square feet heating surface.

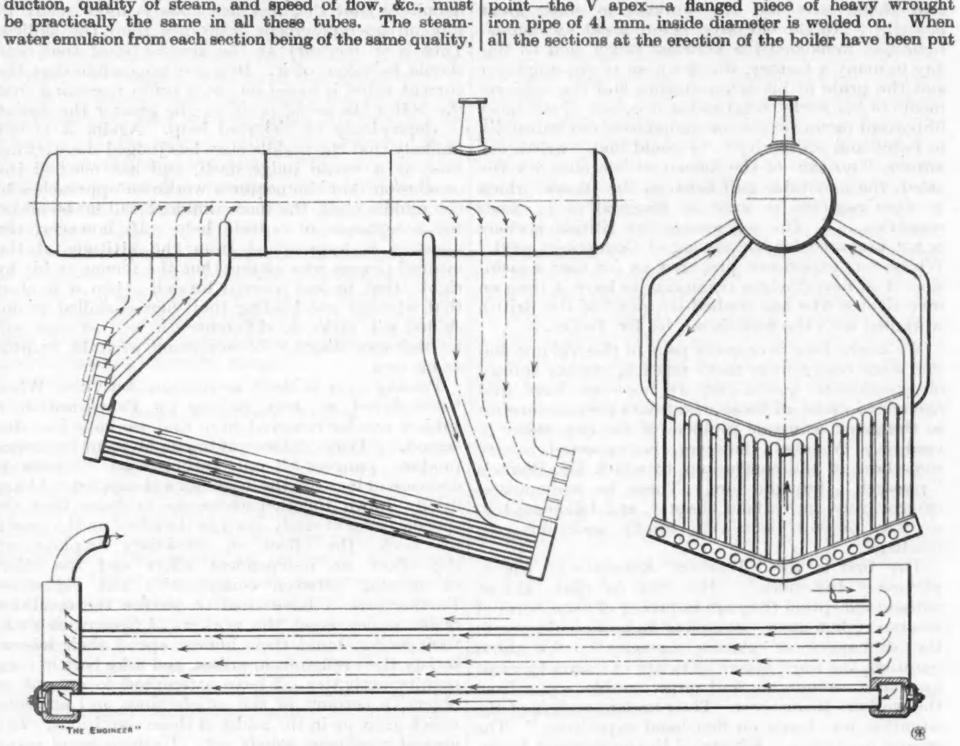


Fig. 1—Diagram of Tube Arrangement of Jiges Boiler

Manufacture.

The manufacture of a Jiges boiler is very simple, and only those machines and tools that are commonly used in any boiler shop are needed. The square tubes for the headers are received from the rolling mills in desired lengths. The internal size is generally 140 mm. by 140 mm. and the thickness of walls has been 19–22 mm. for boilers already built. The end plates at each end of the headers are electrically welded in. The ends of the square tubes are warmed, the roughly fitting square bottom pieces—generally 26–28 mm. thick—are pushed in, and the ends of the headers slightly pressed inwards, and finally the welding is carefully done. The tube holes in the end plates are bored, the header filled with sand, and the bending into V shape is done in an hydraulic press, after the header has been heated in the middle portion, where the bend is to occur. The tube holes and their opposite cleaning holes are afterwards bored out.

On the back of each rear header and at its lowermost point—the V apex—a flanged piece of heavy wrought iron pipe of 41 mm. inside diameter is welded on. When all the sections at the erection of the boiler have been put into place, all these pipes are connected to and by a common drain pipe at the bottom of which the drain valve is placed.

The rear headers are fixed rigidly in place, while the front headers are left free to move.

All the sections—front header, straight water tubes, and back header—are made completely ready in the shop, and there tested under water pressure, and transported to the erecting place ready to be put into position. The risers and downcomers are mechanically bent to exact shapes, and experience has proved that they afterwards fit exactly in their places, so that no unnecessary fitting has to be done, but simply the expanding of the tube joints.

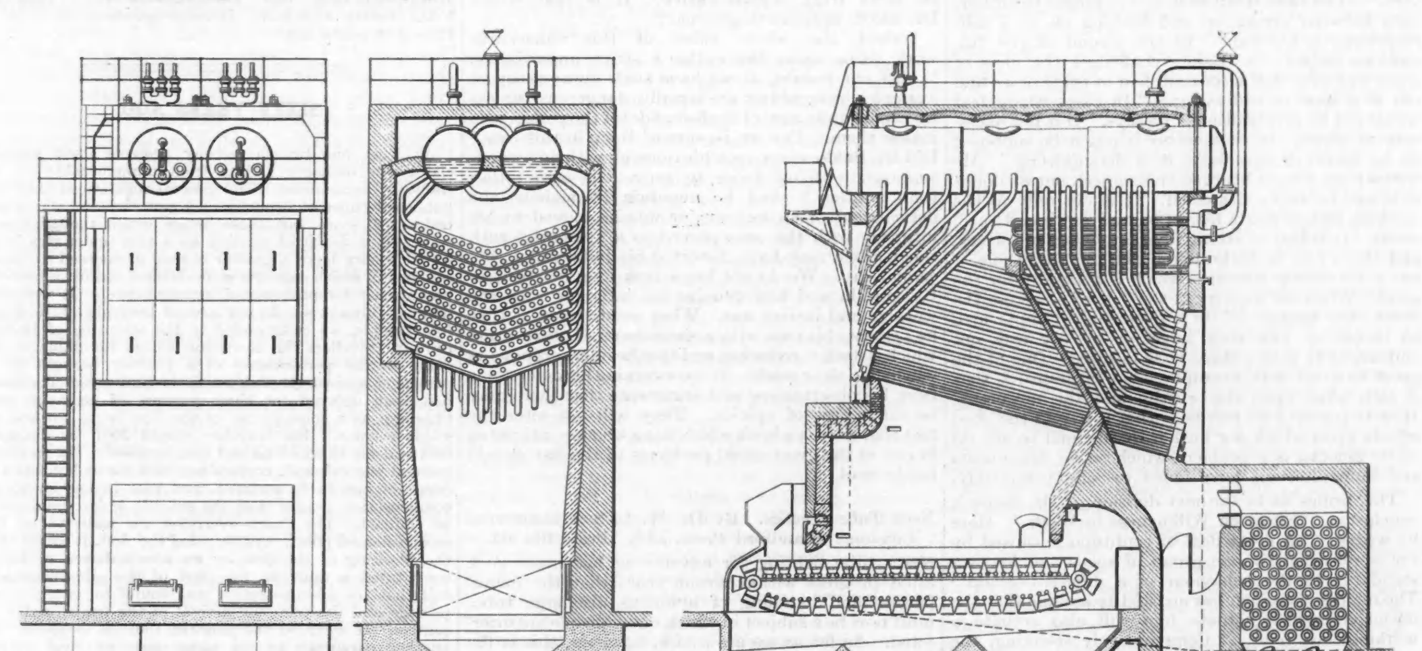


Fig. 2—Jiges Steam Boiler

The framing of the boiler is, of course, ready built in the shop, and after arriving at the site is mounted and screwed together. Riveting, drilling, or similar work at site is completely avoided.

In Sweden the following industries are using Jiges boilers—see Table I.

TABLE I.

Firm.	Number of boilers.	Working pressure. Atm=lb.	Heating surface. Per boiler. m²	Heating surface. Per boiler. square feet.	Heating surface. Total square feet.
1. The Kungsfors Spinning Mill, Skene (Boras)	1	25=375	165=	c/a 1800	1,800
2. The Strömsnäs Paper Mill	1	25=375	350=	3800	3,800
3. The Jönköping Match Factory	1	15=225	300=	3200	3,200
4. The Swedish Sugar Works Co.	2	25=375	450=	5000	10,000
5. The Swedish Sugar Works Co.	3	30=450	450=	5000	15,000
6. The Cement Factory, Limhamn	2	25=375	350=	3200	6,400
Total	10	—		—	40,200

To these are to be added the following Jiges boilers outside Sweden :—

Denmark.—Two boilers for 375 lb. pressure and total heating surface 5000.

Belgium.—Thirteen boilers for 300–450 lb. pressure and total heating surface 36,000.

The total list comprises twenty-five Jiges boilers for working pressures of 225–450 lb. and with a total heating surface of about 81,000 square feet. The smallest of these boilers are only 70 square metres—say, 750 square feet—heating surface and the largest of 600 square metres, or about 6500 square feet heating surface, and for a working pressure of 30 atm.—say, 450 lb. per square inch. The last boiler is fitted with a powdered coal furnace.

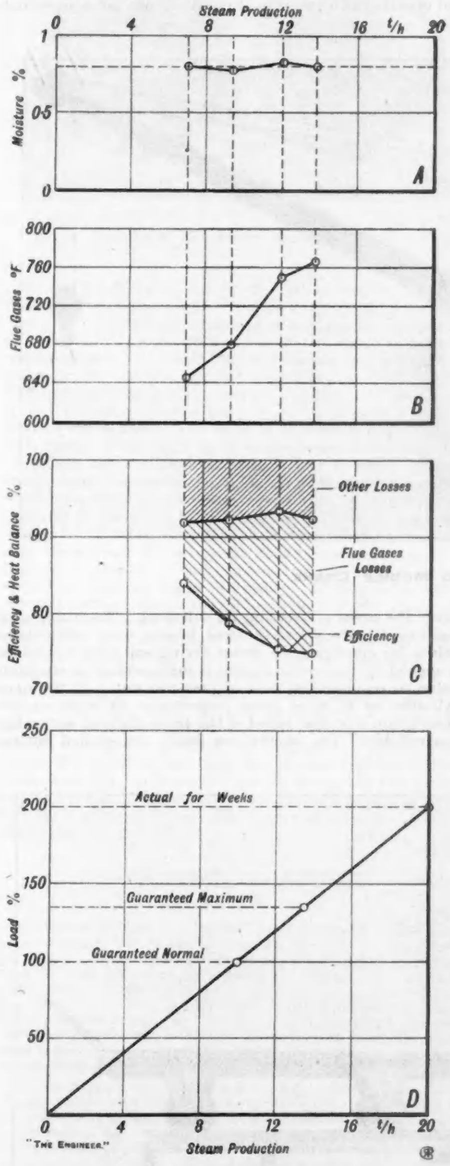


FIG. 3—TESTS OF BOILERS

KUNGSFORS SPINNING MILL.

A few notes about the Swedish plants may be useful. The Kungsfors Spinning Mill, Skene, belongs to the firm Boras Väveri A/B, Boras, Sweden. In it spinning and dyeing are done, the latter process being the principal steam consumer and a very unpleasant one, as the consumption is very varying. The firm ordered in 1926 a Jiges boiler —the first one built—of 165 square metres (about 1800 square feet) heating surface and for a working pressure of 25 atm. (=375 lb. per square inch). The intention was that the steam should, after having passed a steam turbine and a steam accumulator, go to the dyeing department, but as from the beginning neither the steam turbine nor the accumulator was at hand, the boiler during the first period was called upon to deliver steam of only 7–9 atm. (105–135 lb.) pressure directly for dyeing purposes. As that meant that the boiler should, like an accumulator, be able to respond quickly to very sudden changes in steam consumption and to deliver at intervals considerably more steam than the normal and maximum steam production, it was provided with three large steam drums in order to give a large water volume and a large free water surface.

The boiler is fitted with a steam superheater, but no economiser. The stoker is of the "Dano" underfeed type. Cold—that is, not preheated—air is used, but provision is made for the installation of an air preheater later. The fuel is English Duff coal of 5500–6000 fr.-cal. (=9900–10,800 B.Th.U.). The boiler was guaranteed to deliver 4·5 tons of steam per hour when using cold air for the combustion, and 7·5 tons per hour when using preheated air. It has been in regular service since November, 1927.

In Table II. the second column shows the result of test made under the supervision of the Federation of the Boiler-owners of S. Sweden. Notwithstanding the fact that the economiser was not in use and that cold combustion air was used, the boiler produced nearly twice as much steam per hour as was guaranteed, or 8·62 tons per hour, corresponding to 52·2 kilos. per square metre of heating surface. This production was easily reached and that, too, without priming, and although the feed water was anything but good, the content of sodium carbonate being quite high. According to the report of the test, considerably more steam could have been produced if the stoker had been able to burn more coal or if a better quality of coal had been used; but the chimney draught was insufficient for increased forcing.

The thermal efficiency proved to be 75 per cent. for the boiler and superheater, which is regarded as good under the conditions, the temperature in the escaping gases being not less than 424 deg. Cent. (nearly 800 deg. Fah.) on account of the absence of economiser and air preheater surfaces. By introducing an air preheater the thermal efficiency would undoubtedly rise to at least 85 per cent.

Fear that the bent side tubes (risers) would, on account of the bad feed water, give trouble with scale deposits, have fortunately not been realised. Scale is removed from the straight tubes in the usual way.

STROMSNAS PAPER MILL.

The Strömsnäs Paper Mill, Strömsnäs Bruk, Sweden, ordered about at the same time as the above-mentioned firm a Jiges boiler of 350 square metres (=3800 square feet) heating surface and for 25 atm. (=375 lb.) working pressure, and this boiler has also been in use for about 5½ years under a pressure of 150 lb., and after that of 375 lb. It is provided with a superheater and air preheater, but no economiser.

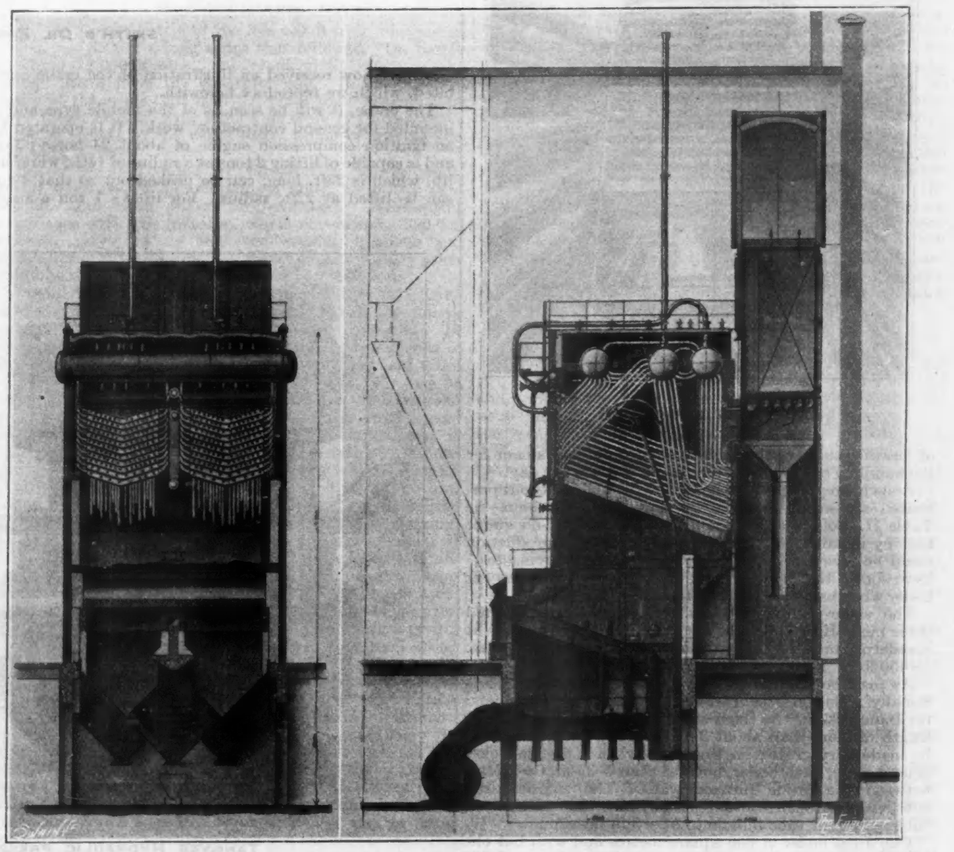


FIG. 4—BOILER FOR A SUGAR WORKS

The stoker is a "Pluto," which is suitable for fuels of the very varying kinds and especially for the Swedish coals of low quality used in this case. These coals contain about 15 per cent. ashes, 16 per cent. moisture, and the heat value is 5000 fr.-cal. per kilogramme (=9000 B.Th.U.) Twelve such stokers have been working since 1917 at the Ormastorp power station with a fuel containing not less than 50 to 60 per cent. of ashes and a heat value of only about 5000 B.Th.U.

TABLE II.—*Evaporation Tests with Jiges Boilers in Sweden.*

Plant	Kungsfors spinning mill	Skivarps beet sugar factory	
Stoker system	Dano-stoker	Dano-stoker	
Heating surface, sq. m.	165·3	450·5	
Grate surface, sq. m.	7	14·5	
Superheater heating surface, sq. m.	27	28·5	
Economiser, sq. m.	—	340	
Test No.	1	1 With economiser	2 Without economiser
Time for test, hrs.	2	9·72	10·5
Working pressure, atm.	20·4	25	25
Temperature of—			
Steam after superheater, deg. Cent.	287	219	221
Air, deg. Cent.	17	22	21
Feed water before economiser, deg. Cent.	85	70·2	96·5
Feed water after economiser, deg. Cent.	—	141·2	107·5
Comb. gases before the economiser, deg. Cent.	424	393	396
Comb. gases after the economiser, deg. Cent.	—	213	—
Content of CO_2, per cent.	14·8	12·6	13·0
Content of CO, per cent.	0·3	0·1	0·1
Fuel	English duff coal	Upper Silesian duff coal	Upper Silesian duff coal
Eff. heat value, Kcal./kilo.	5740	6260	6110
Ashes, per cent.	12·0	9·6	11·5
Moisture, per cent.	13·5	8·6	8·5
Steam production, ton/hour	8·62	29·58*	29·36*
(Normal steam), kg./m².h.	52·2	32·8	32·6
Fuel consumed, ton/h.	1·22	3·57	3·72
kg./m.²h.	164	123	127
Ratio of evaporation, kg./kg.	7·06	8·28	7·90
Heat balance—			
Utilised in—			
Boiler, per cent.	71·8	69·1	71·8
Superheater, per cent.	3·2	3·2	2·9
Economiser, per cent.	—	9·2	—
Efficiency	75·0	81·50	74·7
Loss in chimney gases, per cent.	19·0	10·8	19·5
Loss through combustible gases, per cent.	1·8	0·5	0·7
Other losses, per cent.	4·2	7·2	5·1
Total losses, per cent.	25	18·5	25·3

* Two boilers.

The guaranteed maximum steam production per hour with these coals was 10 tons, but the general average load is 12 to 13 tons per hour, and the boiler runs for weeks, yielding an average of 16 tons per hour and can be forced to deliver 20 tons of steam per hour, which corresponds to about 55·2 kilos. per square metre, or the same as in the case of the Skene boiler before described. Fig. 3, Diagram D, gives further details.

Official tests made in 1928 showed the efficiency of the boiler and superheater to be 84 per cent.—see Fig. 3, Diagram C. On different occasions during the year several other tests were made, partly with and partly without preheating of the combustion air and at different loads, and the results will be found illustrated in Fig. 3. As will be seen, the moisture of the steam before the superheater and at all loads is constant and exceptionally low—0·8 per cent.—an evidence of the excellence of the circulation. As during the past years experience has shown that, even with very sudden changes in load and the greatest steam production changes in moisture of steam before the superheater, and noticeable variations in the temperature of the superheated steam, never occur, one may be entitled to consider that the line of moisture in the steam, within the limits of the loads in question, runs horizontally, as seen in the diagram.

MATCH FACTORY AT JONKOPING.

Since the middle of 1928 a Jiges boiler of 300 square metres (=3200 square feet) has been in daily service at the match factory in Jönköping, Sweden. The working pressure is 15 atm. (=225 lb. per square inch). The boiler is provided with a superheater, but there is neither economiser nor air preheater. The furnace is of the factory's own design, and built as a gas furnace for the use of almost all sorts of wooden rubbish from the factory. A mixture of fifteen different kinds as generally used has about 40 per cent. moisture and a calorific value of 2400 fr. heat units (about 4300 B.Th.U.) per lb. Even by using such a poor fuel, and under the very unfavourable conditions prevailing, the efficiency of the boiler and superheater has proved to be 70 per cent. at an output of 31 kilos. steam per hour per square metre, or 9·3 tons per hour.

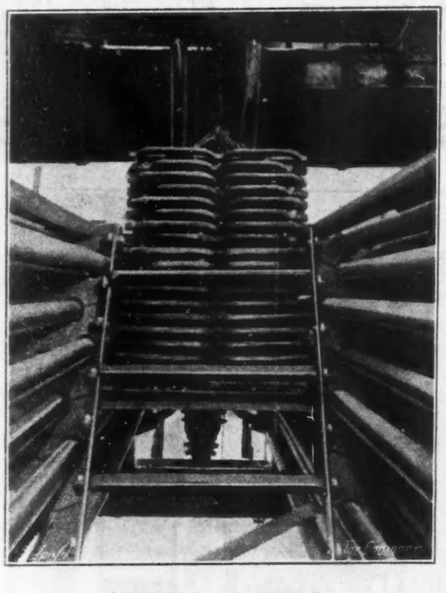
This is, of course, not the limit by far, but as the draught in the chimney at present is, there is no possibility to force the furnace more.

This boiler is working under quite normal conditions, and never exposed to sudden changes or any extraordinary load.

SWEDISH SUGAR WORKS COMPANY.

During the sugar campaigns of 1930, 1931, and 1932, this very extensive concern had two Jiges boilers, each of 450 square metres (about 5000 square feet) heating surface, and designed for a working pressure of 25 atm. (375 lb.) in use at the beet sugar factory in Skivarp.

As a projected steam turbine has not yet been installed, the working pressure is only 7–8 atm. (105–120 lb.). With two boilers, with together only 900 square metres of heating surface, the factory easily produces steam for the handling of some 1500 tons of sugar beets per day.



[FIG. 5—SUPERHEATER]

Tests have proved that the boilers together, without preheated air, easily produce 30 tons steam per hour—as Table II., Cols. 3 and 4 confirms—and there is no doubt that by installing an air preheater the normal production could be raised to 40 tons per hour. Short forcing tests have shown that a steam production of up to 26 tons per boiler when using cold air is attainable.

The same company, early this year (1933) ordered three more Jiges boilers of the same size for its factory at Hasslarp, but for a working pressure of 30 atm. (=450 lb.). These boilers are now in course of erection.

As may be seen from Fig. 4, these boilers are exceptionally wide, on account of the buyer's special demand for Danostokers. As these stokers do not allow a furnace length of more than about 3 m. (=10ft.), the width must be made very great; in this case, when a double-stoker is used under each boiler, not less than 5·35 m. (=17½ft.), between the inside furnace walls. The characteristic subdivision into horizontal sections limits the width of one tube system or tube bundle to a certain maximum.

One Jiges boiler of 600 square metres and with but one tube system is in course of construction and one of 800 square metres has been designed. For boilers over 800 square metres two tube systems will be necessary.

In the 450 square metre boilers here described, two tube systems are used on account of the exceptionally great width of the furnace, and the superheater is placed between the tube bundles (Fig. 5). This arrangement has proved satisfactory, and the superheater works out remarkably small—only 22 square metres—and still very effective, exposed as it is to the radiating heat. It is made of specially fireproofed steel tubes, and experience has shown that the steam temperature is very constant.

CEMENT FACTORY, LIMHAMN.

This factory generally buys electric energy from an outside power company, but has its own steam power station as reserve. During the year 1931 two Jiges boilers, each with 350 square metres heating surface, and for 16–25 atm. working pressure, were installed. They are provided with superheaters and common economisers.

The delivery tests showed that the contracted capacity was easily reached and surpassed, and the efficiency of the boiler, superheater and economiser was at maximum load, 80 per cent.

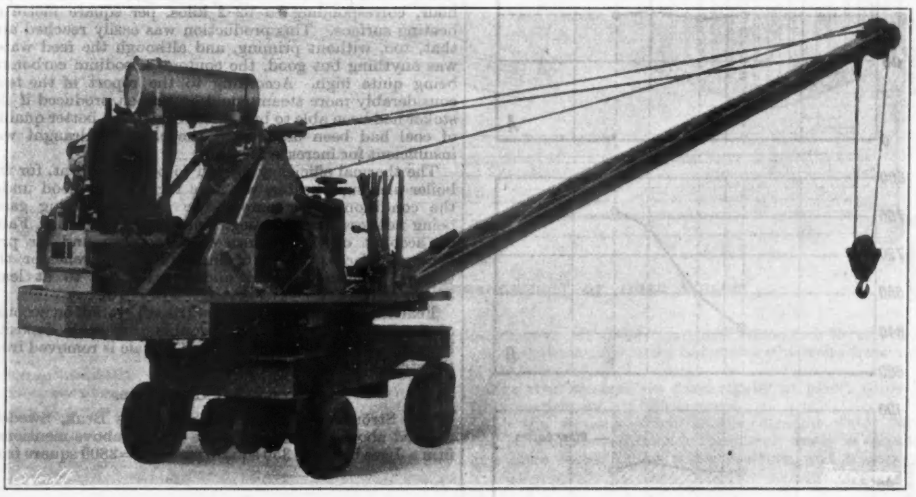
SUPERHEATERS.

In Swedish-built Jiges boilers, with but one tube system, the superheaters are always placed after and above the tube bundle, but may be, as in most of the boilers made by the Belgian licensees, A. F. Smulders, placed after the lowermost section thereof. The superheater may be placed in any desirable place, as this is without any influence on the water circulation in these boilers. In most cases the superheater can be taken out at the back, thus making it possible to build boilers side by side without open spaces between the wide walls.

A Contractor's Crane.

In connection with the Public Works Exhibition at the Royal Agricultural Hall, we made brief reference to the exhibit of Thomas Smith and Sons, of Rodley, near Leeds, and have now received an illustration of the crane exhibited, which we reproduce herewith.

The crane, it will be seen, is of the mobile type and is intended for general contractors' work. It is operated by an ignition compression engine of about 24 horse-power and is capable of lifting 2 tons at a radius of 14ft., while the jib, which is 25ft. long, can be peaked out so that ½ ton can be lifted at 22ft. radius. For lifting 1 ton a single purchase is used, and then the lifting speed is 160ft. per minute. For greater loads a double purchase is used and the speed is reduced to one-half. The crane can be slewed at the rate of five revolutions per minute and the travelling speed is either 4 or 1½ miles per hour. The crane has a fuel consumption of ¾ gallon per hour.

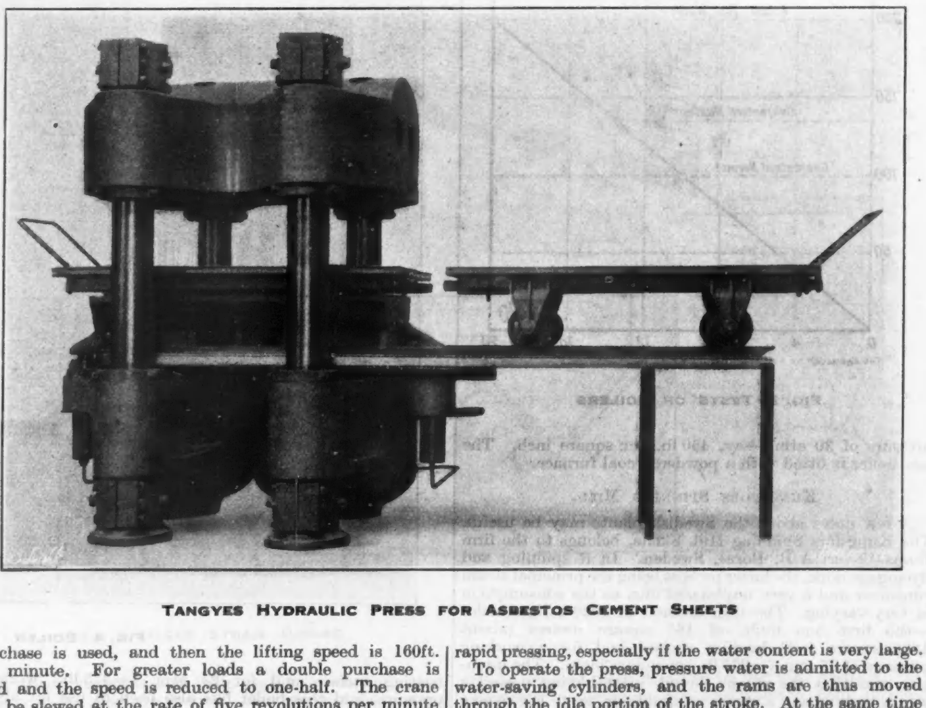


SMITH'S OIL ENGINED MOBILE CRANE

A Hydraulic Press.

The hydraulic press illustrated was made by Tangyes, Ltd., of Cornwall Works, Birmingham, and was designed for the pressing of asbestos cement sheets measuring up to a maximum of 8ft. by 4ft. It is capable of exerting a pressure of 4628 tons. The complete press weighs approximately 80 tons, and is one of the most powerful machines every built for this type of work. It is fitted with two main rams, each 32in. diameter, working in cast steel cylinders. A water-saving device is incorporated in the action of the press, and for this purpose two 5in. diameter rams working in forged steel cylinders are fitted in the main cylinder casting, the rams being connected to the moving table. The head and table of the press are steel castings of massive construction. The columns are made of special quality high-tensile steel, heat treated and normalised, and screwed with a buttress thread to withstand the load. The column nuts are steel castings made in halves, screwed and secured round the columns by the bolts shown. The unit is provided with two trolleys, as shown in the illustration, on to which the material that is to be pressed is loaded. Whilst one trolley is being loaded, the material on the other is being pressed. These trolleys are built up of steel sections, and are provided with troughs round the working surface for collecting and running off the water forced out of the sheets during pressing. The runners are arranged for running on rails and are fitted with ball bearings for easy working. As will readily be seen from the illustration, the trolley is run over the press platen, and then lifted clear of the rails during the pressing stroke in such a manner that the total load is only received on the surface plate in compression. A three-throw vertical motor-driven Tangye pump is supplied to feed the press, and operates at a pressure of nearly 3 tons per square inch when the press is exerting its full load. The valve gear consists of two stainless steel blocks with screw-down valves for operating the water saving and main cylinders. A special by-pass arrangement is incorporated in the main valve to regulate the flow of pressure water to the main cylinder, as it is of great importance in work of this description that the speed of the press shall be accurately controllable. The sheets can easily be spoiled by too rapid pressing, especially if the water content is very large.

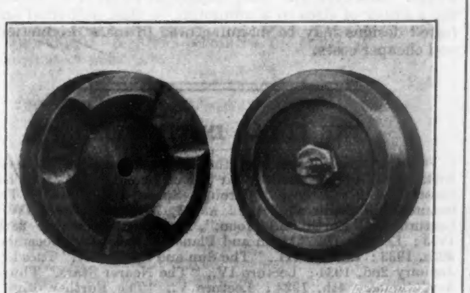
To operate the press, pressure water is admitted to the water-saving cylinders, and the rams are thus moved through the idle portion of the stroke. At the same time gravity feed water is drawn into the main cylinders from an overhead tank through a non-return valve. When the resistance becomes too great for the small cylinders,



TANGYES HYDRAULIC PRESS FOR ASBESTOS CEMENT SHEETS pressure water is admitted to the main cylinders, and thus is only used for the actual pressing operation. After pressing the water is exhausted back to the feed tank. The non-return valve prevents the high-pressure water from flowing into the low-pressure mains when the pressure is on. Although water has been mentioned previously, this actual plant is to be operated with oil.

An Oiliness Comparator.

THE "oiliness" of a lubricant is a measure of its capacity to form a permanent lubricating film on metal surfaces. Physically, it is now recognised to be intimately connected with the union of the oil and metal molecules. It is the essential property which imparts to any oil its lubricating properties. Several machines, generally of a complicated and costly character, have been devised to measure quantitatively the oiliness of a lubricant. In practice a rough-and-ready test of an oil consists of rubbing it between the finger and thumb, but in actual fact such a test can only give a rough idea of the viscosity of the fluid, a property which many other substances destitute of oiliness possess in common with lubricants. The "Aptol" oiliness comparator illustrated herewith has been produced by Sir W. H. Bailey and Co., Ltd., of Salford, Manchester, with the object of providing a simple, cheap and easily applied means of comparing the oiliness of two oils. The device consists of two small cylindrical pieces of cast iron which register together by means of a short pin in one of them and a central hole in the other. The portion with the pin has an annular face about $\frac{1}{8}$in. wide. The other portion has a ridge cut into three sections formed on its face. The crest of this ridge is of a small, but finite width, and as a consequence when the two parts are applied together with a fair amount of force, the pressure between the ridge and the annular surface assumes a considerable value comparable, in fact, with the pressure existing in a loaded bearing. To carry out a test with the device the surface of the ridged portion is smeared with the oil and the two parts, held one in each hand, are brought together. While under fair pressure they are slowly twisted one upon the other. If they turn with a smooth sliding motion, the oil has a high degree of oiliness. If, however, the oil is deficient or poor in this quality, the two pieces tend to chatter or grip, and a distinct feeling of the surfaces biting on one another is experienced. It is essential that after each test the highly tenacious oil film adhering to the surfaces should be removed, in order that it may not upset the results obtained with another oil. For this cleaning process two rubbings with cloths soaked in benzol or petrol are recommended. After several dozen of tests have been made the annular surface becomes worn and has to be repolished by removing the central pin and rubbing the surface on a piece of polishing paper laid on a piece of glass. The ridges of the other portion rarely require polishing.



BAILEY'S OILINESS COMPARATOR

WEATHERING TESTS OF PAINTS.—In connection with a paragraph on page 431 of our issue of November 3rd, the Pyrene Company, Ltd., owners of the patents for Parkerising, remark that Mr. O. Lindermayer's complete article does not deal unfavourably with the Parker process, but only with the particular tests which were started under unfavourable conditions some time ago, and which, it is understood, are still continuing. We may add that the deduction from the words used in our paragraph would support the view that the investigation is proceeding.

A FORCE-FEED OILER.—Joseph Kaye and Sons, Ltd., of Lock Works, Leeds, and 93, High Holborn, W.C.1, have sent to us for inspection a sample of their latest pattern seamless steel forced feed oil can. The body, which is heavily tinned, is serrated where it makes a junction with the cover, in the manner familiar in Kaye cans for many years. Apparently some trifling trouble had been encountered with the thumb button on the plunger, as we are specially informed that in this pattern it has been improved, now being made of sheet brass which is screwed on to the plunger wire before soldering. The spout which is double-wrapped, is fitted with a small perforated strainer. This make of oil can is so well known to engineers that we need not call attention to its robustness; the cans are certainly built for rough usage.

THE ECLIPSE 48. TOOL.—The "Eclipse" 48. tool made by James Neill and Co. (Sheffield), Ltd., consists of a double-ended metal handle slotted and tapped for a set-screw at either extremity. The end of the blade is ground off at an angle and is firmly held in either slot when the set screw is registered with the hole in the blade portion and screwed home. It is supplied complete with short lengths of hack saw blades specially prepared and shaped for its own use. In addition, other varieties of blade have been devised for it. These blades take the forms of a screwdriver, a slitting knife, a file, scrapers, and double-edged saws for cutting slots of different thicknesses. The angle at which the blade is held relatively to the handle is different according as the blade is fixed at one end or the other of the handle. This variation of setting greatly increases the range of usefulness of the tool in tackling many awkward jobs.

Diesel Electric Units of the Buenos Aires Great Southern Railway.*

By P. C. SACCAGGIO.†

BEFORE proceeding, I should like to make it clear that the name "Diesel," which I have used, in no way implies that our motors embody the system devised by Dr. Diesel many years ago. Several British names have a far more legitimate right to be attached to our "compression ignition engines." However, the name "Diesel" has the advantage of being short, and it generally implies "compression ignition engines."

For many years the suburban traffic of the Buenos Aires Great Southern Railway increased at such a rate that, sooner or later, steam traction could no longer fulfil requirements, and the only alternative, as far as could then be seen, would have been electrification. The lay-out of the Southern suburban system consists of three radial lines centring at Plaza Constitución terminal, involving approximately 350 kiloms. of single track, with many junctions and crossings. It is problematical whether suburban services are, as a rule, permanent paying propositions or not; therefore any increase in the already large capital invested in providing for such services is always subject to serious consideration, and naturally the railway authorities felt that before embarking on electrification, other possible systems of traction should be studied.

In the early 'twenties, Diesel traction received an impetus by a few large-sized locomotives built for the Russian railways. Other countries also showed interest in this system of traction, and various attempts were being made. On inquiry we found many manufacturers willing to supply anything that was wanted, but a glance at the majority of the proposed engines did not prove convincing; it was therefore decided to make various visits in order to see some of the engines built for railway work. In the end, although no suitable engines so far built fulfilled our requirements, we obtained sufficiently convincing proofs that engines of about half the size required for the heavy trains we had in mind could be satisfactorily built; accordingly, studies of Diesel-electric power-houses were proceeded with, which finally resulted in a scheme of two eight-cylinder, 700-revolutions, 600 H.P. motor electric units for a five-coach train. This proving satisfactory to the railway authorities and the consulting engineers, Messrs. Livesey, Son and Henderson, two such units were ordered with the object of running them independently or coupled as one train unit.

It was never expected that, from then on, all would be "plain sailing." The inevitable troubles that invariably occur with such enterprises were fully expected. Unfortunately (or I should say fortunately), when the sets arrived, we got all we expected and a good deal more. Now that these units are most well behaved, doing excellent work with the least care bestowed upon them, and with every chance of reaching a good old age of about 1,500,000 kiloms., it is pleasant to look back on past troubles and feel that they were a blessing in disguise. I am convinced that, but for the fact that they did occur, the design and construction of the engines subsequently built and recently received would not have yet been possible. In troublous times real knowledge is acquired, and I shall now tell you a few of the main headaches and how they were cured.

ENGINE FAILURES.

On the first trial trip of the five-coach train one piston failed, the first of a long series that followed. On barely reaching 12,000 kiloms., one crank shaft broke at the second crank from the generator end. In the interval many of the studs that held the main shaft bearing caps were found broken, with a good mixture of broken valve spindles, cracks in the white metal lining of the big end bearings, &c. &c.

Piston troubles ended by substituting the originals, which were cast of an aluminium alloy, by others of a special aluminium alloy drop-stamped. Subsequent experience with this material, which covers some 200,000 kiloms., convinced me that the wearing qualities and durability of these new pistons are far superior to any other piston material I know of, including best cast iron.

The failure of the shaft was caused by the engine momentarily running at the critical speed of the fourth order every time the load was suddenly removed. In engines with eight cylinders in line, the critical speeds of shafts that fall within or near the working range are those of the fourth and eighth orders. The best that can be done is to keep the working revolutions of the shaft well away from them. The critical of the eighth order occurs below the working rotary speed of the engine, and is usually passed at starting at a very high rate of acceleration, so that the time interval in passing it is sufficiently small to avoid harmful synchronisation with the natural period of vibration of the shaft. On stopping the engine the effects of this critical are felt more than in starting, because deceleration is slower and causes the rotation of the shaft to remain for a slightly longer period in its vicinity. Good designers take care that the working revolutions of the engine are about 15 to 20 per cent. above or below these two critical speeds, and as long as the unloading of the engines is done gradually, thus giving ample time for the speed governor to act, the rotary speed of the shaft never reaches the critical speed of the fourth order. In train operation the power to the traction motors must be cut off almost instantaneously, but the friction and inertia of the parts of the fuel control mechanism operated by the speed governor of the engine delay its governing action, so much so that for a short period the engine accelerates, and does (or may) reach the critical rotary speed of the fourth order. Should such conditions occur frequently, sooner or later a broken shaft will be the result. Such fractures occur suddenly, and do bring home to the uninitiated the meaning of the effects resulting from torsional vibrations if they happen to synchronise with the natural period of shafts.

Means to prevent such serious troubles appeared a most formidable task. Dashpots and other mechanisms for delaying motion of the control handle when the train conductor wished to cut off power from the train motors were thought of, but found impracticable, and it was only after many disappointments that a simple appliance was found by means of which the fuel supply to the engine cylinders is cut off as soon as the train conductor begins to move the control handle in the direction of unloading. This new arrangement not only avoided engine racing and the breakage of shafts; it also cured a series of other troubles, such as the breaking of studs of the main shaft bearing cap already mentioned, pipes, joints of all descriptions, and other small breakages and slackness that used to occur in the vehicle body; in fact, the vibrations that were set up on the whole structure when the engines were suddenly unloaded have disappeared, and we now realise how formidable they were, although at first we were more or less inclined to accept them as inevitable evils.

I have mentioned valve failures. These usually occurred at the end of the stem where it was screwed to a tappet head or where the stem joined the valve body. A modified design that does away with the threading of the stem, combined with a more uniform change of cross section from stem to valve, ended these troubles.

The cracking and peeling away of the anti-friction metal lining from the bronze backing of big-end bearings was overcome by reducing the thickness of this metal to about $\frac{1}{16}$in., and assuring good adherence to the bronze backing. We have had bearings in good condition after 75,000 kiloms., but although we knew the technique of how this work should be correctly done, not all bearings are equally successful, a good deal depends on the human element, which we are endeavouring to substitute by more certain means. The cracking of the anti-friction metal of these bearings is also influenced by incorrect combustion, or by what has come to be known as "Diesel knock," more or less recognised as part and parcel of the system. Such "Diesel knocks" act like terrific blows on all bearings and the shaft—they should never exist with well-designed injection nozzles and combustion chambers, but each engine requires individual treatment.

Failures caused by the sheer ignorance of the mechanics were by no means few. However, they have since become proficient after a good deal of intense training. I have found that the average railway mechanic is ill-adapted for this class of work. A good staff can, however, be formed from selection amongst young apprentices, who, as a rule, are keen on anything new, and after many mistakes turn out really good at their profession.

OVERLOADING.

After most of the engine defects were put right, and we hoped for better times, there still remained an important point to attend to; means to prevent train conductors from overloading the engines. The trains were put in motion and accelerated by reducing by hand the resistance of the electrical circuit of the magnetic field of the generator in a series of notches, and as the hand control was never correctly operated, the engines were most of the time either under or overloaded. To guide the conductor, signals of various sorts which indicated when the engines were approaching or had reached full load were provided, but the results were never satisfactory. Overloading of Diesel engines can only lead to slowing down, with the consequent overheating of cylinders, pistons, valves, &c., resulting in increased maintenance costs. Further, by not maintaining a steady full load on the engine, the acceleration of the train suffered. It became evident that this system of traction could never be a complete success until some automatic means was found to load up the engine quickly and maintain full load during all working periods, which was successfully accomplished some time ago by an automatic control. With this control the train conductor has no signals or other instruments to attend to—his function is reduced to moving the controller handle in one direction for starting and the reverse for stopping the train, and a casual peep at the vacuum brake gauge. By this mechanism we were also able to do away with many other electrical fittings and complications, so much so that the forty-four small conductors laid from one end of the train to the other, which we previously needed, have been reduced to ten, and we shall not rest satisfied until they have been brought down to six. If one remembers that the failure of any of these conductors interferes with the working of a train, it will be realised how necessary it is to reduce potential failures to a minimum.

FURTHER PROGRESS.

In 1930 we had made sufficient progress with the two experimental power-houses to warrant further studies and preparation of schemes for the heavier weight of train required, and the motor units lately received are the result. These new Diesel engines are probably the best of their type so far built; the general arrangement having been published in various technical papers, I assume you are acquainted with it. My opinion is that they can be made a design and type likely to remain standard for many years.

Although the suburban scheme of Diesel-electric traction is in itself most interesting, technically and financially considered, the major railway problem consists in cheapening transport generally, and in view of the potential economies of Diesel-electric traction for other work, a main line locomotive with two motor electric units duplicate with those of the power-house was ordered.

It may be of interest to know that it has been definitely proved that with the total H.P. available from the two Diesel groups, we can, on any part of our suburban system, with trains stopping at all intermediate stations, arrive at destination in the same running time that we could obtain from ordinary electrification.

It has been remarked that a suburban service worked by Diesel-electric power-houses is bound to result in high operating costs—in the first place there is the dead weight of the power-house to be hauled about with the train, also the fact that heavy block trains entail unnecessary coach kilometrage during slack periods. Taking the last objection first, there is nothing to prevent us from making the train units half the size of the high-capacity train we now fill up at all the peak hours. It would not entail any extra capital outlay in power-houses, because their design permits of their being separated into two units, neither are there any reasons why we should not add or take off vehicles from a train, but with the short time intervals between peaks (four in the day) the saving in money likely to result from so doing would not be sufficient to pay the wages of the required shunters. Regarding the objection of hauling the extra weight of the power-house, it may not be generally known that the tare weight per seat of our large-capacity train, including the weight of the power-house, is about the same as that of the modern stock used on electrified lines, and considerably less than that of the older passenger stock of those lines. The large-capacity carriages we use—entirely a Southern Railway product—permit a low tare per seat. Of course, it may be argued that the same carriages could be used on ordinary standard electrification, but that is another story; it is not quite as easy as it looks.

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* Address to members of the Institution of Mechanical Engineers in Buenos Aires, June 28th, 1933. Slightly abridged.

† Technical Adviser, Buenos Aires Great Southern Railway.

Operating Costs.

Now a few remarks about operating costs. We obtain 1 kilowatt-hour at the traction motor terminals at the expenditure of 250 grammes of fuel oil, representing, including lubricants, a total cost of production of 1½ cents paper, or less than 0·2d. at present rate of exchange, and it should be remembered that no labour is employed for producing the necessary power. Electric energy is only used when the train is being propelled. In coasting, or at the instant of cutting off the current from the traction motors, the engines themselves are stopped, and all wastages avoided. The train conductor's wages alone represent about one-third of the cost of producing the required power. On these conditions we could afford to be extravagant in our working as far as power cost is concerned. To complete the picture of cost of power, to the cost of fuel and lubricant must be added the maintenance cost of the power-house motor electric units, plus interest and depreciation of their capital cost. As far as interest and depreciation is concerned, I have already said that the capital expenditure required for motor electric units is not more than that involved in a central power station, nor is the depreciation of a travelling power-house, as it can be built to-day, any greater. Compare the cost of 1½ cents paper per kilowatt-hour produced by the Diesel motor units with the price usually paid for electric current delivered at a central station bus-bars. Add to this cost that represented by the losses incurred in transmission, track leakages, and the electrical energy forcibly wasted in resistances, &c., and you will find that the difference in cost of power between the two systems will leave a substantial margin in favour of Diesel traction, and more than sufficient to cover maintenance, interest, depreciation, and any other charges, real or fictitious, that may be imputed to Diesel power-houses. Maintenance cost of Diesel engines has been the subject of many controversies and discussions. Many engineers still consider that it must necessarily be very high, but some day they will receive a great surprise when they will eventually discover that it is not so. Diesel engines, suitable for railway traction and built from now on, must be capable of running at least 20,000 kiloms. without requiring any major adjustments. On completing this mileage a few days should suffice to do whatever is necessary to make them fit for a further run of 20,000 kiloms., and so on until 150,000 kiloms. is reached, when a general overhaul will be due. What will be the cost of a general overhaul? It will be found considerably less than that required by steam locomotives of equal H.P., and service kilometrage. Any Diesel engine that does not come up to this standard of performance should be scrapped. Before dismissing the subject of Diesel mobile power-houses for suburban train service, I wish to call attention to the large capital expenditure needed for ordinary electrification in the way of distribution system, sub-stations, track equipment, &c., all of which must be provided at the very commencement of electrification on a scale to suit the maximum working capacity of the line, whether the volume of traffic then offered is existent, or merely potentially remote. The maintenance cost of this large equipment is a very appreciable amount, and cannot be ignored in making comparisons between the two systems of traction.

Main Line Traction.

Regarding main line trains, it is only a few days ago that a test run with the Diesel-electric locomotive hauling a passenger train of 591 tons was made. The distance travelled was 120 kiloms. with four intermediate stops. A maximum speed of 98 kiloms. per hour was reached, the running speed of the whole trip averaging 82 kiloms. per hour with a fuel consumption of 3·25 kilos. per train-kilometre. From experience, I find that on equal services the fuel consumption of Diesel-electric locomotives averages in weight between one-fourth to one-fifth that consumed by superheated steam engines using fuel oil. The consumption ratio between fuel oil and coal with our steam services is one of oil to 1·25 of Welsh coal. Practice has shown that the fuel consumption of Diesel engines does not vary to any appreciable extent from one general repair to another. The fuel consumption of the two original power-houses remained practically constant from the time they were put in service until withdrawn for general repairs after having run 125,000 train-kilometres. By that time several pistons had been working without the top rings, due to excessive wear of the grooves on the pistons, into which other rings could no longer be fitted.

The general trend of discussions, comparisons, &c., shows that Diesel traction is now receiving a good deal of attention from the engineering professions. In the final sifting of it all we shall no doubt get to the true facts.

Oil *v.* Steam Locomotives.

In making comparisons between Diesel and steam traction, it is often found that the basis of comparisons is not always correct. Not long ago there came to my notice a most interesting study made on this subject, giving long columns of comparative figures relating to capital and working costs of an assumed large railway. After pondering over these figures for many hours, I was forced to the conclusion that they served no useful purpose, because the figures relating to Diesel traction were merely assumptions and not facts. It is quite useless to compare to-day's cost of steam with that of a Diesel locomotive. In the first case we are dealing with a highly competitive business, in more or less moribund conditions, bolstered up by accepting orders often at ruinous prices. On the other hand, the present-day prices of Diesels merely represent what manufacturers would like to get for their ware, and in no way what would be paid in a competitive market.

Locomotives, in themselves, do not represent the total capital expenditure involved in the power-producing plant of a steam railway; there are other large expenditures in running sheds, land, building tracks, turntables, water supply throughout the system, without which a steam locomotive is useless. These costly adjuncts must be included in the total capital cost of motive power. Of course, as regards railways that have already reached their full expansive capacity, and have spent large sums on sheds, &c., Diesel traction does not offer them the same advantage that it does to other railways which still continue to expand, as is the case with most railways in this country. There is yet another saving to the credit of Diesel, represented by the large amount of money locked up in spare parts stocked at all running sheds. Diesel locomotives carry their own "running shed," whilst the only spares needed consist of about four valves, a couple of big end bearings, and an assortment of other small items. Conditions and environment in which mechanical repairs to steam locomotives are carried out in dark, wet running-shed pits, compare very unfavourably with the nice and well-lit vehicles, with every facility for doing the little amount of running repairs that a Diesel engine requires. Consider how the *morale* of the maintenance staff would be raised by the improved conditions and better work, benefits which cannot be computed in cold figures, but are, nevertheless, great advantages to the general working of a railway. To get at the real truth, facts must be squarely faced, every *pro* and *con* must be carefully scrutinised, and once this is done I have no doubt as to which the final winner will be in this hard-fought contest. Diesel traction no longer needs defence; it is pushing its way forward, and I feel certain that the time is not far distant when no progressive railway executive can afford to ignore its existence, be their railways happily situated near a waterfall or having coal mines on their property. Diesel traction offers many other advantages, besides a reduced fuel cost and the doubling or trebling of the mileage obtainable per working unit. A Diesel locomotive requires no rest days and is easily supplied with fuel and lubricant, which is about all that it needs between periodical revisions at distant dates.

Question of Design.

In the course of time and from experience gained, I have come to several conclusions, amongst which are the following:—It was generally considered, and still is, amongst certain engineers, that Diesel engines required very substantial foundations on which to rest and on which to be secured. Such foundations usually take the form of rigid frames of the steam locomotive type or other similarly built-up structures.

Every part of a Diesel engine is subject to vibrations of various frequencies, which as a rule damp themselves out, provided that the engine is not too rigidly held. The moment restriction of vibrations is introduced in the form of rigid frames troubles occur, either in the engine itself or in other parts of the structure. A rigid frame transmits to the Diesel engine all the shocks that emanate from the rolling of the wheels over the track. These shocks may become very destructive by the gyroscopic effects produced on the gyrating engine shaft and its supports. The safest way out of the difficulty is to give the engine ample freedom by resting it on a common vehicle frame, supported on well sprung bogies. You will notice, when visiting our power-houses, that a person walking along the vehicle causes the body of same to move in unison with each footstep. These power-houses ride very well at all speeds. The main line Diesel-electric locomotive was also built on the same principles of carriage, and at the high speed of 130 kiloms. per hour the riding was very steady. I have found that to obtain good riding qualities the mass and location of the various weights that constitute the locomotive must be considered in relation to the centre of the rotating shaft. I have not yet been able to unravel this intricate problem in all its details, but I think we are getting somewhere near to be able to formulate definite rulings.

It is considered, and supported by reputed trials, that nose-suspended traction motors are unsuitable for high-speed electric locomotives. The alleged defect of this system of drive is that at high speeds the motor wheels of the bogies cause a lateral pressure on the track amounting to as much as 40 per cent. of the static load carried by the wheel, resulting in a destructive effect to the track, apart from the potential danger of derailment. Recently we had the opportunity of testing our main line Diesel locomotive at speeds up to 130 kiloms. per hour, taking curves with the greatest ease at 100 kiloms. per hour that would have been risky at 70 kiloms. with a steam locomotive. The riding is equal to that of a passenger car—in no case did we notice any "nosing" or serious joltings going over points and crossings. That the underhung roller bearing axle-boxes used on this locomotive prevent any undue lateral pressure being exerted on the track, was proved by the absence of signs on the wheel flanges of having rubbed against the rails. This experience is confirmed by a similar experience in connection with large passenger vehicles fitted with these bearings, involving many hundreds of thousands of vehicle kilometres. These results have convinced me that bogie vehicles are by far the best wheeling arrangement for railway locomotives, and it should go far towards cheapening production if the large driving coupled wheels that have become more or less standard with electric locomotives can be avoided. There is also a good deal I should like to tell you regarding design of bogies, motor suspension, &c., which, however, cannot be adequately dealt with in an address.

A 1000 H.P. Diesel-electric group of a total weight of 32 tons can be produced, from which a locomotive on two four-wheel bogies, all motored, of 82 tons total weight can be built. A Diesel-electric locomotive can be made capable of turning its full horse-power into tractive effort from a train speed of 7 kiloms. per hour up to the maximum designed speed; therefore, the 82 tons are barely sufficient to provide the necessary adhesion for the very large tractive force available at very slow speeds; think of the complications in the way of boosters on a steam locomotive in order to obtain similar results; the facility with which any number of Diesel-electric locomotives can be worked automatically by one driver from the leading engine; a number of comparatively small units of 1000 H.P. give more service for capital invested than a series of large units, be they of the twin type or single-motored; the flexibility of this system should appeal to all railway engineers. After all, a 1000 H.P. is not to be despised; it can deal with a 350-ton passenger train at any speed required in this country or haul a 1200-ton cargo train with ease. It might be said that a passenger locomotive could not be used for cargo, or *vice versâ*, to which I would answer that there is not going to be a passenger and cargo Diesel-electric locomotive, but only one locomotive for both services. Here I am somewhat anticipating; in any case, it indicates the lines that are being followed.

The weight of 21 tons on the driving wheels of Diesel-electric locomotives is in no way excessive for bogies with a wheel base of not less than 1·75 the track gauge. The unsprung weight will be about 3 tons or less than the weight of a steam locomotive driving wheel and axle. As far as track is concerned, the 21 tons will cause about the same stresses as a steam locomotive driving wheel with a static load of 18½ tons, remembering that twice in each revolution of the driving wheel the static that it sustains is increased by at least 12 per cent., by the resultant of steam pressure on the piston and the varying angularity of the connecting-rod. On lines where this axle load could not be considered, six-wheeled bogies can be used. I have seen an excellent design of an all-wheels-motored bogie of this type that should give excellent results, and would not be too rigid on curves.

For shunting at yards, depôts or for running light trains, the 500 H.P. and possibly the 700 H.P. may be found useful. However, the most important point is to restrict the number of sizes to a minimum, so that well-tried and tested designs may be manufactured in mass production, and cheaper costs.

THE ROYAL INSTITUTION.

The Christmas lectures of the Royal Institution of Great Britain will be presented by Sir James Jeans, F.R.S., who has chosen for his subject "Through Space and Time." The lectures will begin at 3 p.m. at 21, Albemarle-street, W.1. Lecture I., "Earth and Moon," Thursday, December 28th, 1933; Lecture II., "Moon and Planets," Saturday, December 30th, 1933; Lecture III., "The Sun and its Family," Tuesday, January 2nd, 1934; Lecture IV., "The Nearer Stars," Thursday, January 4th, 1934; Lecture V., "The Further Stars," Saturday, January 6th, 1934; Lecture VI., "The Nebulæ," Tuesday, January 9th, 1934. The subscription for this series of juvenile lectures will be: juveniles (aged 10–16), half-a-guinea; adults (non-members), one guinea.

LAUNCHES AND TRIAL TRIPS.

Arc, steel motor barge; built by Richard Dunston, Ltd., to the order of the Electricity Department of the Leeds Corporation. Oil, engines 50 B.H.P. "Widdop" Diesel; trial trip, November 29th.

Steel barge; built by Henry Scarr, Ltd., Hessle, near Hull; dimensions, 75ft. 6in. by 14ft. 9in. by 7ft.; to carry coal on the Yorkshire waterways; launch, November 29th.

Steam-driven cutter suction dredger; built by Wm. Simons and Co., Ltd., to the order of the Chinese Purchasing Commission, under the direction of Sir J. H. Biles and Co. This dredger is to be used for keeping a clear berth for the Nanking Train Ferry, China. Launched with all machinery on board and steam up, December 1st.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Schiess - Defries, Dusseldorf, has appointed Schiess-Defries (Gt. Britain), Ltd., of 25, Victoria-street, London, S.W.1, sole representatives in Great Britain for the whole of its interests.

A. C. Wickman, Ltd., Coventry, have been appointed the sole selling agents in Great Britain for the Humphris patent open-fronted and inclinable presses, which are made by Mass Products, Ltd., Newtown, Parkstone, Dorset.

Mr. Archibald J. Boyd has been appointed managing director of Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd., in succession to Mr. Arthur S. Bailey, O.B.E., who will retire at the end of the present year.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

Merryweather and Sons have received from the Manchester City Council an order for an all-British motor turntable fire escape with all-steel ladder, capable of extension to a height of 100ft.

C. A. Parsons and Co., Ltd., of Newcastle-on-Tyne, have received an order for a large turbo-compressor capable of delivering 900,000 cubic feet of gas per hour at an absolute pressure of 154 lb. per square inch. The compressor will run at 5670 r.p.m. and will be driven by step-up gearing from a steam turbine running at 3300 r.p.m.

Scientific Management.—Progress is being made with the organisation of the Sixth International Congress for Scientific Management, which is to be held in London from July 15th to 18th in 1935. A strong Council, which includes representatives of societies connected with some phase of scientific management, has been formed. The Chairmen of the Committees are Dr. E. F. Armstrong, F.R.S. (Organisation), Sir Henry Fowler (Technical), and Mr. G. R. Freeman, F.C.A. (Finance). Mr. H. Ward, late General Secretary of the National Institute of Industrial Psychology, has been appointed Secretary. Amongst the questions which will be discussed are:—(*a*) Concrete Examples of the Application of Scientific Management to Distribution Problems in Manufacturing, Wholesaling and Retailing; (*b*) Methods of Controlling Production; (*c*) Methods of Selection, Education and Training of *Personnel* Suitable for High Administrative Positions; (*d*) What are the Correct Methods of Inculcating Modern Management Principles and Practices in Large-scale, Medium, and Small Undertakings? What is the *Rôle* of Trade or other Associations in this Field?

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The World's Steel Market.

The situation in the Continental steel markets has improved somewhat of late, and more orders have been received by the works, although these have not been sufficient to establish a sound rate of operation. Amongst the business taken have been orders from the Soviet Government, totalling about 15,000 tons of structural material and plates, of which about 11,000 tons were badly needed orders for thick plates. It is understood plate contracts will be executed by Belgian works, whilst the orders for structural steel will go to French works. Rather more stable exchange rates have resulted in a slight cheapening of Continental steel export prices in sterling, the reduction being about 1s. 6d. Business in Continental steel in the British market has been more active of late, but not on a scale to cause anxiety to British makers. Japanese competition, however, has been felt in India principally in the section of the market which takes the cheaper descriptions of steel supplied by the Continent. It is also reported that there are signs that sellers of Japanese steel are trying to gain an entry into the South African market. In the United States the increasing costs of production have resulted in the announcement of price advances on a wide range of finished steel materials.

Semi-finished Material.

The stringency in this market is noticeably more pronounced, and consumers are becoming nervous regarding the position, not only because of the lack of assurance regarding future supplies, but also in view of the strong tendency for prices to rise. A few months ago British billets could be obtained freely at £5 d/d, and sheet bars at £4 15s. It is not easy now to find sellers willing to accept £5 7s. 6d. and £5 5s. respectively. Many producers are so well supplied with orders that they stand out for £5 10s. to £5 12s. 6d. in the case of billets. Business in sheet bars has improved lately, and this has enabled the makers to advance their quotations; but the variation in the quotations for this material is greater than for billets. In Wales and on the North-East Coast the quotation for sheet bars is £5; but in the Midlands, where considerable supplies are obtained from outside districts, the general price is £5 5s. From all districts, however, the story comes of works being booked up and of delays in deliveries, so that it is not surprising that the volume of business going abroad has been increasing recently. The prices of Continental material also have a strong tendency to advance. The sale of foreign supplies is in the hands of a pool in London composed of representatives of the Continental works, firms which, since the European Steel Cartel adopted its new sales policy some months ago, have ousted the British merchants who formerly handled part of this trade. This organisation considers each transaction upon its merits. This policy has disadvantages as well as advantages. It enables the pool to keep a complete control of the market for foreign semis in Great Britain; but it also promotes much uncertainty amongst consumers, who are never sure of how near to the market price they are buying. The answer is that there is no genuine market price under these conditions and this is certainly true, since consumers report a wide variation. In Wales, for instance, a parcel of sheet bars was sold recently at £4 1s. delivered; in Scotland billets were quoted at £4 17s. 6d.; and in the Midlands sellers claim to have obtained £5 10s. delivered. Lately the quantities offered in the British market have not been large.

The North-East Coast and Yorkshire.

The demand for finished steel materials has not been affected so far by the usual seasonal influences. In fact, in some departments the volume of business has increased instead of showing the usual decline. The heavy engineering trades are making progress, and this is reflected in a better demand for steel materials. Business, however, rests largely upon the home trade demand, and although some expansion is noticeable in exports, any important increase is checked by the operation of high tariffs, quotas, and exchange difficulties. On the North-East Coast the improvement in the shipbuilding industry which has taken place on the Clyde has not yet reached the Tyne and the Tees. S. P. Austin and Sons, of Sunderland, have, however, taken orders for three steamers of about 3000 tons deadweight from Cory Collieries, Ltd., and the ship repairing yards remain busy. The structural engineering shops in this district are well employed, and their demands are reflected in active conditions at the steel works. The position of the latter has also been strengthened by the receipt of an order for 2200 tons of structural steel from the New Zealand Government. The rail department also is busy on an order for tramway rails for the London Transport Board. In Yorkshire many of the works are operating almost at full capacity, whilst the promising nature of the outlook can be gauged by the fact that negotiations between the employers' organisations and the trade unions are in progress regarding work being continued over week-ends. Compared with last year, 10 per cent. more men are now employed in the Sheffield engineering and steel-making industries.

The Midlands and South Wales.

The busy conditions which have ruled in the finished steel department of the Midland industry show no signs of relaxing. Although the structural engineering concerns complain that they have still a certain amount of unemployed plant, conditions in this respect are improving, and some of the recent orders given out should take the place of contracts which are being completed. The re-rollers in particular have heavy order books and their output is largely sold for several weeks ahead. Beyond this they are not anxious to go, as the outlook regarding prices for semis and other raw materials is by no means sure. Quotations for re-rolled small steel bars are fairly steady at £7 5s. to £7 10s., whilst the steel works quote £7 10s. to £8 10s. For export the re-rollers' lowest figure is now £6 15s. f.o.b. Continental sellers continue to offer small steel bars at £6 10s. 6d., d/d Midlands, but although a fair tonnage of orders has been placed the quantities sold have not been so great as might have been expected in view of the margin in favour of the imported material. Continental strip is also quoted at well below the British price at £7 10s. to £8 5s., the home producers quoting £8 5s. to £9 10s. One of the departments which has shown most definite signs of improvement is that providing steel for the collieries, and a fair amount of forward business has been arranged. In South Wales the tin-plate industry, although it is working at a good rate, is suffering from the effects of the depreciated dollar exchange. Not only have the Welsh works lost orders to the Continent by as much as 3s. per box, but buyers on the export markets generally hesitate to place orders until the exchange becomes more stabilised. For a few weeks now the production has been in excess of sales. On the other hand, the steel works in South Wales are busy.

Scotland and Lancashire.

A much improved tone rules in the Scottish steel market since the recent orders for new ships. The total tonnage placed on the Clyde and at Belfast in November, which will provide orders for the Scottish steel works, totalled about 130,000 tons, and it is estimated that 60,000 tons of steel will be required. The constructional engineering firms are not particularly busy, but their position has been improved by some fresh contracts. Export business has been on a poor scale, trading with Canada having suffered the decline always experienced in the winter, and business with other export markets having been checked by the instability of the dollar exchange. The Lancashire market has been fairly active of late and a fair volume of business has been transacted, particularly in the lighter sections of the industry. Business in the machine tool department, for instance, has been on a fairly good scale and hopes are entertained of securing more orders from the Russian Government. It is announced that Mr. R. Greenwood, managing director, and Mr. J. H. Rivers, chief designer, of Craven Bros. (Manchester), Ltd., are visiting Moscow at the invitation of the Soviet Central Engineering Authority to discuss new business. This firm, during the past two years, has completed some large contracts for machine tools for Russia. Conditions at the plate mills has considerably improved on the recent orders for locomotives and other contracts. The demand for sheets, however, is a weak spot, and although trade in galvanised sheets with India has slightly increased of late, there is a considerable amount of unemployed plant in this section of the industry. In the Barrow district it is reported that the steel works have sufficient orders on their books to ensure employment over the first quarter of 1934, and both at Barrow and Workington the mills are rolling rails, billets, slabs, and hoops.

Current Business.

The most important contracts reaching the British iron and steel trade this week were from the Great Western Railway, which placed orders with Guest, Keen and Nettlefolds, Ltd., for 100,000 steel sleepers, weighing 10,500 tons; 10,000 tons of chairs and 25,000 tons of steel rails. An order for 5000 tons of steel rails was also given to the Lancashire Steel Corporation, Ltd. These contracts are part of the Great Western Railway Company's 1934 relaying programme and amount to 50,500 tons of steel. The arrival of 3000 tons of black plates at Port Sarnia, Ontario, from South Wales, marks the beginning of an interesting enterprise on the part of Richard Thomas and Co., Ltd. The intention is to erect a tinning works in Canada to meet American competition in the Dominion tin-plate market. By exporting black plates and tinning them in Canada, the company hopes to obtain the benefit of the Canadian anti-dumping duty. At present no tin-plates are manufactured in the Dominion and under these conditions the Americans are able to secure advantages which they will lose when the plates are made in Canada. The Department of Overseas Trade announces that the following contracts are open for tender:—Brazil, Rio Grande do Sul State Railways, steel superstructures for three railway bridges (Brazil, February 12th); Persia, Municipality of Tehran, supply of plant, including boilers, turbo-alternators, switchboard transformers, and cables for proposed electric power station (Tehran, January 7th); Tokio, H.M. Consul reports that a local firm desires quotations from United Kingdom manufacturers of billets, sheet bars and tube strip; Egypt, Ministry of the Interior, cast iron spigot and socket pipes, double socket couplings, lead wool (Cairo, January 10th); South African Railways and Harbours, train lamps and fittings (Johannesburg, January 15th); supply, delivery and erection of structural steel and ironwork for a cargo shed, Port Elizabeth Harbour (Johannesburg, January 22nd); U.S.A., a firm wishes to get into touch with United Kingdom manufacturers of spring steel plates, 7in. by $7\frac{3}{8}$in. by $\frac{3}{16}$in., and 7in. by $10\frac{1}{4}$in. by $\frac{3}{16}$in., bent to a curve.

Copper and Tin.

The demand for electrolytic copper has improved somewhat over the week, although business is still on a restricted scale. Agreement has not yet been reached upon the American "code," but some of its provisions have been published. According to these another attempt will be made to go direct to consumers and to eliminate the merchants. Whilst Copper Exporters Incorporated (the copper trust) was in existence, this attitude prevailed, and, in the view of many, was partly responsible for the unfortunate position in which the industry finds itself. Lately the policy of the producers has changed, and they have shown a disposition to deal through merchants. The export quotation this week has ruled at 7·70c. to 7·75c., or about £33 5s. to £33 10s. c.i.f. In Europe the most active buyers of electrolytic copper have been Italy and Germany. Trading in the United States also has been dull, and the domestic price has been reduced to 8c. d/d. Business in the London standard market has been quiet on the whole, but a few important buying orders were placed towards the end of the week and, in the poor conditions prevailing, had an effect upon the market disproportionate to their weight. The position in this market has been improved by the liquidation of stale bull accounts, and most of those now in existence are in strong hands. . . . Although business in the tin market has been rather uninteresting, prices registered a moderate advance following the publication of the favourable November statistics. According to Mr. W. H. Gartsen's figures, there was a reduction of 1850 tons in the visible supply, compared with the figures at the end of October, and there was also a reduction of 499 tons in the carry over in the Straits Settlements. At the Arnheim Smelter, however, the carry over increased by 216 tons. One of the most notable features of the statistics was the disappointing deliveries to the United States, which totalled only 3350 tons, compared with 6035 tons in October. The American deliveries for December, however, may be more satisfactory, as American dealers are showing more interest in the market. The Continental demand has been light, but there are indications that more tin is being used in this country.

Lead and Spelter.

Business in lead has been rather less active than in the earlier part of November, but the consumption is probably on a larger scale than at any corresponding season for years past. This is partly due to the fact that building operations, as we have pointed out, have been continued with little interruption later into the winter than usual. The wide contango which rules in the market is due to declarations of Mexican lead which, of course, will go into warehouse. There are already nearly 10,000 tons of lead in bonded warehouse in this country, and in spite of re-exports to Russia last month, there was an increase in these stocks of nearly 300 tons. The cessation of operations at the Mt. Isa mine in Australia has not affected the market, and in view of the heavy stocks in Australia it will probably be a long time before prices will be influenced. . . . Steady conditions have ruled in the spelter market and prices have moved within narrow limits. The industrial demand remains light and is likely to do so until a more sustained improvement manifests itself in the situation in the galvanised sheet market. Consumers are dissatisfied with the position which enables the Empire producers to charge premiums upon the Metal Exchange quotation for their metal. The position is that spelter of foreign origin has to pay a duty of 10 per cent., whilst Empire spelter is allowed free entry. The price quoted on the Metal Exchange does not include the duty which has to be paid by the buyer in the event of his receiving metal in bonded warehouse. This, of course, gives the Empire producers an opportunity of charging a price under the actual figure for bonded spelter and above the Metal Exchange quotation. The Empire producers have always quoted a premium; but originally this was about 2s. 6d. Latterly it has been in the neighbourhood of £1. Within the last few days, however, it has dropped to 15s.

Average Metal Quotations.

The London Metal Exchange official average quotations for November show a decline in all departments of the market excepting tin. This is the fourth month in succession in which the average prices have fallen. The average price for cash tin for November, however, was £2 5s. 8d. and for three months £2 19s. 11d. higher than for October. The fall in copper has been heavier than in other metals, the electrolytic quotation being £3 0s. 8d. lower than for October and wire bars £2 19s. 9d. less. Standard cash copper is £3 1s. 4d. down and three months £3 1s. 11d. The comparative steadiness of lead prices is indicated by the small decline of 5s. 4d. in the average price for "Shipment in the current month," compared with the October quotation, whilst the price for shipment the third following month dropped 6s. 6d., the decline in the mean price being 5s. 11d. There has been a distinct drop in the average price of spelter for November, the quotation for "Shipment in the current month" being 15s. 2d., and for shipment the third month following £1 5s. less than in October, whilst the mean price dropped by £1 5s. 2d. The following are the official average quotations:—

STANDARD COPPER	Cash.. ..	£30	12	6
	3 Months..	£30	15	$3\frac{1}{4}$
	Settlement	£30	12	6
ELECTROLYTIC COPPER	.. .. ..	£34	6	$4\frac{4}{11}$
ELECTROLYTIC WIRE BARS ..	.. .. ..	£34	14	$9\frac{3}{11}$
BEST SELECTED COPPER.. ..	.. .. ..	£33	16	3
STANDARD TIN	Cash.. ..	£226	16	$3\frac{15}{22}$
	3 Months..	£226	8	$10\frac{4}{11}$
	Settlement	£226	16	$4\frac{4}{11}$
LEAD	For shipment the current month ..	£11	10	$8\frac{19}{22}$
	For shipment the third following month	£11	15	$6\frac{9}{11}$
	Mean	£11	13	$1\frac{37}{44}$
	Settlement	£11	11	$1\frac{7}{11}$
SPELTER	For shipment the current month..	£15	0	$11\frac{14}{22}$
	For shipment the third following month	£15	6	$11\frac{18}{22}$
	Mean	£15	3	$11\frac{8}{11}$
	Settlement	£15	1	3

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	£ s. d.	£ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland—	*(D/d Teesside Area)*	
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
Midlands—		
Staffs.—	*(Delivered to Black Country Station)*	
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

(Basic iron prices subject to a rebate of 5/-.)

MANUFACTURED IRON.

	Home.	Export.
	£ s. d.	£ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 10 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 15 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/6 to 16/9.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/-
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/-
„ „ „ 1 p.c. carbon	£35 12 6	10/-
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10¼ per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, December 6th.

	Home.	Export.
Copper—		
Cash	£30 2 6 to £30 5 0	
Three months	£30 3 9 to £30 5 0	
Electrolytic	£33 0 0 to £33 15 0	
Best Selected Ingots, d/d Birmingham	£33 15 0	
Sheets, Hot Rolled	£60 0 0	
Tubes, Solid Drawn (basis)	9¾d.	9¾d.
„ Brazed (basis)	9¾d.	9¾d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
Tubes, Solid Drawn, 2/1 alloy	8¾d.	8¾d.
„ Brazed	10¾d.	10¾d.
Tin—		
Cash	£227 5 0 to £227 7 6	
Three months	£227 5 0 to £227 7 6	
Lead:	£11 12 6 to £11 17 6	
Spelter:	£14 17 6 to £15 3 9	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/6 to 13/-
„ Glasgow— Ell	13/- to 15/6
„ „ Splint	16/3 to 16/6
Ayrshire	
(f.o.b. Ports)—Steam	13/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/9 to 14/-
Unscreened Navigation	12/3 to 13/-
Lothians—	
(f.o.b. Leith)—Hartley Prime	14/-
Secondary Steam	13/6

ENGLAND.

	Inland.	
Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/6 to 20/6
Furnace Coke		13/- to 17/6
Northumberland—		
Blyth Best		14/- to 14/3
„ Second		12/9 to 13/-
„ Best Small		10/-
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/8
Foundry Coke		17/- to 18/6
Sheffield—		
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	22/- to 24/-	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	6/- to 9/-	—
Nutty Slacks	7/- to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	18/- to 18/6
Best Steam Smalls	13/6 to 14/-
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 27/-
Foundry Coke	19/- to 36/-
Furnace Coke	17/6 to 18/6
Patent Fuel	21/-
Swansea—	
Anthracite Coals:	
Best Large	35/- to 38/6
Machine-made Cobbles	35/- to 48/6
Nuts	37/6 to 48/6
Beans	25/- to 30/-
Peas	18/- to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/- to 20/-
Nuts	18/- to 25/-
Smalls	11/- to 13/-

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Surtax.

From usually reliable sources it is affirmed at the moment of writing that it has been decided to suppress the surtax of 15 per cent. on British goods imported into France. A decree to this effect, it is believed, is to be published during the week, when an unfair fiscal imposition which has caused so much friction between the two countries would be definitely removed.* In taking this step the Government has had to override a strongly organised opposition from industries which are interested in maintaining the tax, but, on the other hand, the suppression of the tax was inevitable in view of the disastrous effect which the threatened British reprisals in the form of an additional tax of 21 per cent. on certain French goods would have had on French exporting industries. The Lyons industries, for example, implored the Government to take immediate action in order to avoid their utter ruin. Another factor in influencing the Government to suppress the surtax is the impossibility of applying it to the devaluated dollar, owing to swift reprisals that would have followed from the United States at a time when the French expect to benefit considerably from the repeal of the prohibition law. There now remains the 6 per cent. turnover tax which was instituted by law, and can therefore only be repealed by a Bill which is now before the Chamber of Deputies for that purpose, though there are provisions in the law suppressing the tax under certain conditions. Having been abrogated in the case of Belgium and of some other countries, there would appear to be no reason why it should not be suppressed on British goods. It is, nevertheless, to be hoped that the Bill to repeal the turnover tax will be carried through Parliament without further delay, and thereby remove the only obstacle that stands in the way of a resumption of negotiations for a commercial treaty between the two countries. The whole fiscal system has broken down, and a new trade policy must be inaugurated if the country is to recover its industrial and commercial activity. This can only be done gradually, and French manufacturers are promised that the suppression of the surtax will be accompanied by an extension of import quotas, but that method of restriction will have to be applied with prudence if the Government hopes to succeed in its efforts to put the trade policy of the country on a workable basis.

An Exhibition of Quality.

The holding of an exhibition in the Grand Palais, Paris, with the idea of associating quality with French manufactures is an interesting experiment, and if carried out on the lines proposed by its originator, the President of the Federation of Mechanical Industries, the Salon de la Qualité Française would have been instructive. The Exhibition was intended to produce a reaction against mass production, which has, moreover, already fallen into discredit, and to convince buyers of the quality of French goods by showing examples of craftsmanship in all branches of the manufacturing industries. To this extent it cannot be said that the experiment has entirely succeeded. The Salon de la Qualité Française covers too much ground, and there are few examples of individual crafts. Some metallurgical companies exhibit drop forgings and engineering firms have stands with models of harbours and photographs of bridges and other works; while colliery companies give prominence to domestic composite fuels called " artificial anthracite," or by names suggestive of anthracite. The aircraft and motor car industries are partly represented. The Exhibition is more popular than technically interesting. It had been hoped that the Salon de la Qualité Française would have demonstrated industries in which French artisanship particularly excels and helped in the work of industrial decentralisation which introduced art and quality into essentially French manufactures until small industries suffered from the development of big workshops and factories.

The Industrial Situation.

Financial and economic difficulties are having a depressing effect upon the engineering industries, which see little hope of relief unless something is done to put in hand a programme of public works that will include railway building, bridge construction, and possibly the Trans-Saharan Railway. The engineering industries are endeavouring to get as much of their own work as possible into the new programme, which, nevertheless, has no chance of being put in hand until the country's financial situation has undergone a considerable improvement. Hardly any success has attended the efforts of manufacturers to secure orders abroad, particularly when they are dependent on conditions of reciprocity which this country cannot accept. This was the case with the contract for the erection of a sugar-making plant in the Irish Free State, which a French firm failed to obtain, notwithstanding the backing it received from the French Government. The failure is attributed to the fact that the Government was unable to grant to the Irish Free State a sufficient import quota for agricultural produce, and the order therefore went to a German firm, whose Government is stated to have accepted conditions for the importation of Irish cattle. The situation is becoming extremely complicated when so many countries are inclined to carry the principle of reciprocity to an extreme. Where credits are required to secure foreign contracts, manufacturers can usually obtain from the banks all the facilities they need, but the difficulties with reciprocal exchanges are giving rise to the belief that the system is not without drawbacks. Close attention is given to Turkey, where French manufacturers are well represented and are prepared to offer long-term credits for State contracts, and the negotiations now in progress with the Soviet Government are more complicated because they involve import quotas as well as credits. Meanwhile, the only satisfactory feature is the work given to shipbuilders by the Navy Department, and by some of the shipping companies. Locomotive and wagon builders are still waiting for orders that ought to have been distributed at the beginning of the year.

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* The decree referred to had not been issued up to the moment of going to press.—Ed. The E.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

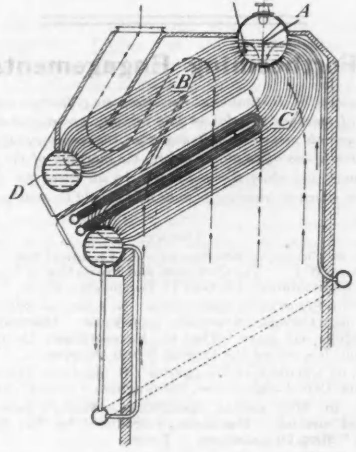
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

396,119. February 5th, 1932.—Water-tube Boilers, A. Williams, 16, Messaline-avenue, Acton, London, W.3.

The inventor points out that, on account of the difference of temperature to which the opposite sides of the drums of a water-tube boiler are subjected, they suffer stresses which limit their practicable length. He aims to overcome this difficulty by providing a system of circulation through the tubes that embraces the whole length of the drums. This is effected by a series of longitudinal and transverse baffles. In the steam drum there is a longitudinal baffle A, which reaches nearly to the ends and separates the heating tubes B from the steam raising tubes C. There are also transverse baffles, both in the steam drum and in the water drum D, which are intended to make a circulation of the water from end to end of the drums positive. The feed-water is injected into the tubes from the steam drum at E.—*August 3rd*, 1933.

Nº396,119

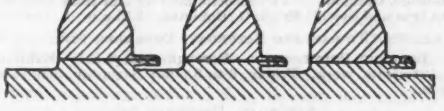


TURBINE-MACHINERY.

400,534. April 27th, 1933.—Turbine Discs, Aktiengesellschaft Brown, Boveri et Cie., Baden, Switzerland.

The discs of steam and/or gas turbines are liable to become loose on their shafts on account of temperature changes causing expansion and contraction. The inventors consequently fix the discs on the shaft by means of thin fins welded together at their extremities. The fins are sufficiently flexible to accommodate the expansion and contraction. The illustration needs no comment.—*October 26th*, 1933.

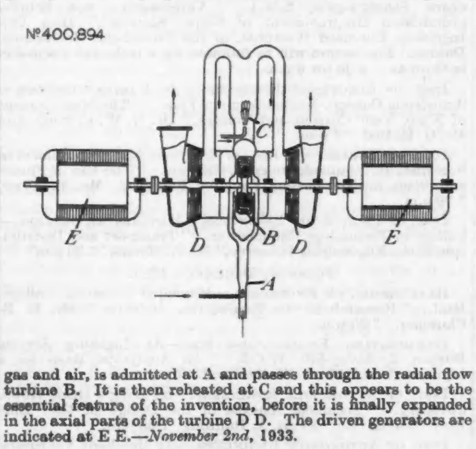
Nº400,534



400,894. July 6th, 1933.—Gas Turbines, Aktiebolaget Milo, Kungsgatan 32, Stockholm, Sweden.

This gas turbine would appear to be designed on the broad principles of the Ljungstrom steam turbine. The working fluid, gas and air, is admitted at A and passes through the radial flow turbine B. It is then reheated at C and this appears to be the essential feature of the invention, before it is finally expanded in the axial parts of the turbine D D. The driven generators are indicated at E E.—*November 2nd*, 1933.

Nº400,894

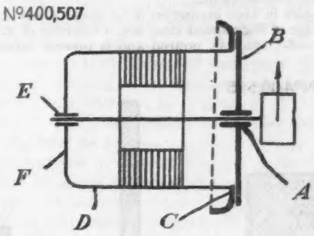


DYNAMOS AND MOTORS.

400,507. March 23rd, 1933.—Sheet Metal Casings for Electric Motors, The Skoda Works, Plzen, 37n, Jungmannova, Prague II, Czechoslovakia.

A sheet metal casing for small and medium size A.C. motors is described in this specification. The driving end bearing A is arranged in a stiff plate B, which is attached to the casing by a dished plate forming a wall C in such a way that turning and bending moments set up by the driving torque are taken up by this plate. The forces which reach the rear feet D through the belt pulley and the bearing E in the base F of the pot-shaped casing are very small, so that the construction of the casing is cheap, as the pot-shaped part is almost entirely free from load and can be constructed from comparatively thin sheet metal.—*October 26th*, 1933.

Nº400,507

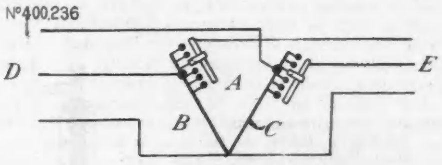


TRANSFORMERS AND CONVERTERS.

400,236. March 18th, 1932.—Electric Transformers, *International General Electric Company, Inc., of* 120, *Broadway, New York, U.S.A.*

In the case of high-system voltages with relatively small outputs, the dimensions of the tap-changing equipment become very considerable in comparison with those of the transformer, and it is correspondingly expensive. Apart from this, however, difficulties are encountered in combining it with the transformer, since with high voltages adequate spacing is necessary between the individual phases. These disadvantages are avoided, according to the invention. A is an auto-transformer in open delta connection with the main windings B and C, which are arranged on two limbs of a three-phase core. The free ends of the windings are provided with tappings. The unregulated system D is permanently connected to three points of the main windings, while the regulated system E is connected with one phase to the vertex of the main windings, and the other two phases are connected through the tappings to the open ends of the main windings. By adjusting corresponding taps on the two windings it is possible to effect a change in voltage on system E, while maintaining the symmetry of the voltage triangle and the phase angle of the transformation unchanged.—*October 18th*, 1933.

Nº400,236

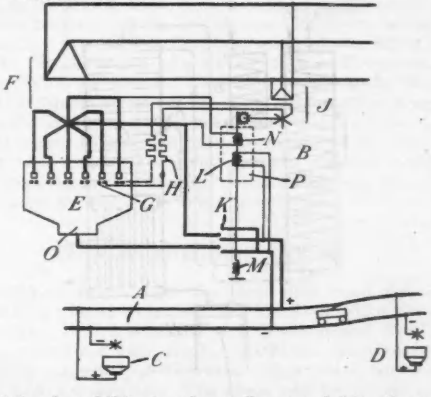


TRAMWAYS AND RAILWAYS.

400,688. May 10th, 1932.—Recovery of Energy in an Electric Current Distributing System, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

A scheme is described in this specification for permitting regeneration on a traction system fed with rectifiers. A is the trolley wire of a railway system, which is fed from mercury vapour valves placed at the sub-stations B C D. The rectifiers in the sub-stations C and D are without grid control. The valve at the sub-station B on the inclined section of the track is to be capable of being used both as a rectifier and as an inverter for the recovery of the braking energy of a train travelling down hill. It is therefore provided with a grid control for enabling the moment of ignition of the anodes or the application of positive or negative potentials to the grids to be controlled. The rectifier and inverter E is connected over the transformer F to the A.C. network. The grids G are fed over the resistances H from the phase-shifting transformer J. K is a change-over switch which is held under control by the relay coil L and the spring M, if the coil N is disregarded. By means of this change-over switch K the cathode O and the neutral point of the secondary winding of the transformer F are connected alternatively to the positive trolley wire or the negative rail of the conducting system of the railway. The change-over switch K and the phase-shifting transformer J are coupled together and are simultaneously operated by the relay P. Normally the change-over switch K occupies the intermediate position shown, the relay coil L and the spring M being suitably balanced. When a train travels down the inclined section and it is desired to recover the energy, the voltage in the trolley wire will increase. Consequently the relay coil L is more strongly excited and the switch K is changed over in opposition to the force of the spring in such a manner that the cathode O is connected to the negative rail and the star point of the transformer F to the positive trolley wire. At the same time the transformer J is displaced and the grid control so adjusted that the valve E acting as an inverter returns the braking energy of the train to the primary network. The magnitude of the return energy can be adjusted and limited, for instance, by the displacement of the phase displacer J, which influences the grid control, being limited by stops, or by a regulator which is dependent on current or voltage. The change over may equally well be effected in accordance with the voltage differences between the alternating and continuous current voltage. The relay P will in this case be provided with an exciter coil N, which is fed by the A.C. voltage in addition to the coil L which is fed by the continuous current voltage, the two coils acting in opposition to one another.—*November 2nd*, 1933.

Nº400,688



MACHINE TOOLS AND SHOP APPLIANCES.

400,565. June 30th, 1933.—**Hacksaw Blades**, The Henry G. Thompson and Son Company, Chapel and Mill Streets, New Haven, Connecticut.

The object of this invention is to make a saw blade with a cutting edge of high-speed steel and a backing of mild steel. A billet of mild steel is poured and is pierced down its length.

Nº400,565

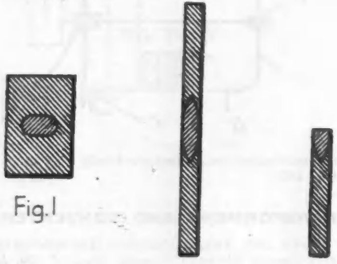


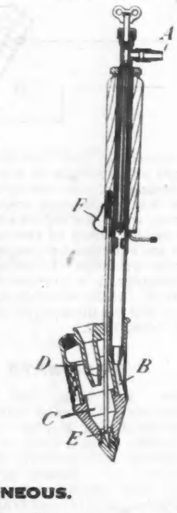
Fig. 1 Fig. 2 Fig. 3

The cavity is filled with high-speed steel as shown in Fig. 1. The billet is then rolled down, as shown in Fig. 2, so that the mild steel is squeezed away from the sides of the high-speed core. The strip is then split along the centre—see Fig. 3—and the saw teeth cut and set in the usual fashion.—*October 26th*, 1933.

399,374. February 6th, 1933.—**Soldering Irons**, A. G. Bain Muirhead, Head of Mine, Denny, Stirlingshire.

This is a gas-heated soldering iron with a reservoir for molten solder. The gas is supplied at A and burns in the annular chamber B round the reservoir C. Solder is fed in through the spout D, which prevents the spilling of the molten solder if the tool is laid down. A valve E, operated by the trigger F, is used to regulate the outflow of the solder.—*October 5th*, 1933.

Nº399,374

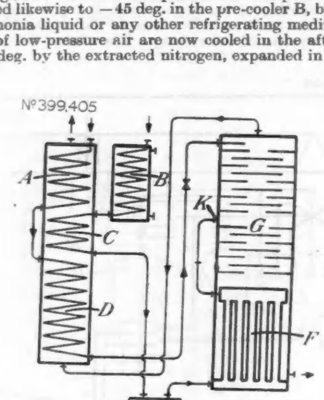


MISCELLANEOUS.

399,405. March 11th, 1933.—**The Decomposition of Gas Mixtures with Low Evaporation Point**, Mapag Maschinenfabrik Augsburg-Plattling A.G., and M. Frankl, 234, Ulmerstrasse, Augsburg, Germany.

This invention is concerned with the production of oxygen from atmospheric air. The apparatus comprises the high-pressure pre-cooler A, the low-pressure pre-cooler B operated by evaporating ammonia liquid, the low-pressure after-cooler C, the liquefier D, the evaporator F, the rectifier G, and the expansion engine H. In the pre-cooler A 3 cbm. of high-pressure air at about 200 atm. are cooled by the extracted nitrogen to − 45 deg., also 5 cbm. of low-pressure air compressed to 4 atm. are cooled likewise to − 45 deg. in the pre-cooler B, by evaporating ammonia liquid or any other refrigerating medium. These 5 cbm. of low-pressure air are now cooled in the after-cooler C to − 65 deg. by the extracted nitrogen, expanded in the expansion engine H to 0·2 atm. compression and led into the evaporator F at − 120 deg. in order to evaporate the liquid rectification-oxygen (1·75 cbm.) by sensible heat supply, whereby this air is cooled to − 180 deg. Following this, this air is now led through K into the rectifier G, in order to enrich the wash liquid (2·75 cbm.) to 50 per cent. O_2 content. The further rectification of the wash liquid to the desired O_2 content then takes place in the lower part of the rectifier and is effected by the evaporating rectification-oxygen (1·75 cbm.). Since the quantity of liquid amounts to 2·75 cbm., 1 cbm. O_2 can be withdrawn from the apparatus and carried away. The 3 cbm. of high-pressure air are led out of the pre-cooler A to the liquefier D and there completely liquefied by the extracted nitrogen (7 cbm.) and after-cooled to − 190 deg., in order then to be poured in at the top of the rectifier. Of the 3 cbm. of liquefied high-pressure air, about 0·25 cbm. evaporate by expansion from 200 atm. to the atmospheric pressure of distillation, so that still 2·75 cbm. remain as wash liquid. This new process, it is claimed, possesses the great advanatage of low-pressure operation in the expansion engine and a very simple and cheap construction of the evaporator of the separating column, since this has to withstand, on both sides, only atmospheric pressure and operates at a temperature difference of $182 - \frac{130+180}{2} = 27$ deg., whereas in all other cases only 3–5 deg. are available. The dimensions of the evaporating surface may therefore be considerably smaller. If the liquid oxygen obtained is evaporated in heat exchange relation with high-pressure air, the major portion of the refrigeration is recovered. The installation has now only to make up the refrigeration losses. For that the pressure of the high-pressure air can be considerably reduced and the refrigeration performance of the expansion engine can be cut out. Since 1 cbm. of wash liquid is now produced by the evaporated oxygen, only 2 cbm. of high-pressure air need be liquefied in the apparatus. The refrigeration of the nitrogen is then sufficient to cool to about − 120 deg. the air blown in which is intended for the evporation by sensible heat. If the oxygen is withdrawn from the apparatus in gaseous form, then instead of 1·75 cbm., 2·75 cbm. oxygen must be evaporated in the separator. For this purpose the air for effecting evaporation need only be cooled to about − 80 deg. Since, when withdrawing oxygen in gaseous form, its refrigeration—that is, the refrigeration of the high boiling component—can also serve for cooling the air to be separated, cooling to this temperature without the aid of an expansion engine is possible.—*October 5th*, 1933.

Nº399,405



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Inst. of Chemical Engineers.—At Chemical Soc., Burlington House, W.1. "The Corrosion and Protection of Magnesium and its Light Alloys," Dr. Guy D. Bengough. 6 p.m.

Inst. of Electrical Engineers: N. Eastern Students.—Armstrong College, Newcastle-upon-Tyne. Discussion, Mr. A. H. Miller will move "That the Extraordinary Development of Science has caused the Present World Depression." 7 p.m.

Inst. of Electrical Engineers: S. Midland Students.—At Boots' Café, Colmore-row, Birmingham. Annual dance.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Discussion, introduced by Mr. A. Perry-Keene, "Shop Organisation." 7 p.m.

Inst. of Metals.—In the Non-ferrous Section of the Applied Science Dept. of the University, Sheffield. "Modern Application of Electric Heat," Mr. J. C. Howard. 7.30 p.m.

Inst. of Production Engineers: Western Section.—Merchant Venturers' College, Bristol. "Modern Production Acetylene Welding," Mr. C. Helsby. 7.30 p.m.

Junior Inst. of Engineers.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. Presidential address, "Newton's Third Law of Motion and Some Dynamics," Mr. W. J. Tennant. 7.45 p.m.

Manchester Assoc. of Engineers.—At Engineers' Club, Manchester. Quarterly meeting. "Engineering Estimates," Mr. Frank Walker. 7.15 p.m.

Railway Club.—57, Fetter-lane, E.C.4. "Signalling, Remote Control," Mr. Edward Wallis. 7.30 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse, "The Making of a Sheet of Glass," Major R. M. Weeks. 9 p.m.

Smithfield Club Show.—At Royal Agricultural Hall, Islington, N.1. 9 a.m.

West of Scotland Iron and Steel Inst.—Royal Technical College, Glasgow. "The Electric Melting and Heat Treatment of Iron and Steel," Mr. A. G. Robiette. 7.15 p.m.

TO-DAY AND SATURDAY, DECEMBER 9TH.

Borough Polytechnic.—Borough-road, S.E.1. Exhibition of students' work. Friday, 6 to 9 p.m.; Saturday, 2.30 to 9.30 p.m.

SATURDAY, DECEMBER 9TH.

Inst. of Civil Engineers.—Students' afternoon visit to Battersea Power Station of the London Power Company, Ltd.

Inst. of Marine Engineers.—The Minories, E.C.3. Junior Section's social and dance. 7.30 p.m. to 11.15 p.m.

Stephenson Locomotive Soc.—Headquarters, King's Cross Station, N.1. Annual general meeting, 3 p.m., Midland Grand Hotel, St. Pancras, N.1. Annual dinner, 6.30 p.m.

MONDAY, DECEMBER 11TH.

Engineers' German Circle.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Verbesserung von Schiffsgrundrissen (Improvement of Ships' Sections)," Herr Dr.-Ingenieur Eberhard Westphal, of the Technische Hochschule, Danzig. The lecture will be followed by a technical discussion in German. 5.30 for 6 p.m.

Inst. of Electrical Engineers: N. Eastern Centre.—Armstrong College, Newcastle-upon-Tyne. "The Measurement of X-ray Tube Current and Voltage," Dr. G. W. C. Kaye and Mr. G. E. Bell. 7 p.m.

Inst. of Metals.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "The Use of Fluxes and Slags in Non-ferrous Foundry Practice," Mr. T. Tyrie. 7.30 p.m.

Inst. of Production Engineers: Manchester Section.—College of Technology, Manchester. "Transport and Distribution in the Engineering Industry," Mr. A. Mycoe. 7.30 p.m.

TUESDAY, DECEMBER 12TH.

Hull Assoc. of Engineers.—Municipal Technical College, Hull. "Research in the Engineering Industry," Mr. B. B. Churcher. 7.30 p.m.

Illuminating Engineering Soc.—At Lighting Service Bureau, 2, Savoy-hill, W.C.2. "An Analytical Basis for a Lighting Code," Mr. A. W. Beuttsell. 7 p.m.

Inst. of Automobile Engineers.—At King's Head Hotel, Coventry. "Technical Aspects of the Design of the 'Blue Bird' Racing Car," Mr. R. A. Railton. 7.30 p.m.

Inst. of Automobile Engineers.—At Merchant Venturers' Technical College, Bristol. "Transmission Principles," Mr. L. H. Pomeroy. 7 p.m.

Inst. of British Foundrymen: Burnley Section.—Municipal College, Burnley. "Developments in Foundry Refractories," Mr. E. J. Crawley. 7.30 p.m.

Inst. of Electrical Engineers: N. Midland Students.—Hotel Metropole, Leeds. "Problems Night." 7.15 p.m.

Inst. of Electrical Engineers: Scottish Centre.—At N. British Station Hotel, Edinburgh. Mr. N. C. Bridge will open discussion on "The Costing of Production at Selected Stations." 7 p.m.

Inst. of Marine Engineers.—The Minories, E.C.3. "Notes on the Manufacture of Piston Rings and their Relation to Liner Wear," Mr. H. J. Young. 6 p.m.

Inst. of Mechanical Engineers: N. Western Branch, Graduates.—Engineers' Club, Manchester. "Bauer Wach Exhaust Steam Turbines," Mr. E. Crossley. 7.15 p.m.

Inst. of Metals.—Y.M.C.A., Swansea. "Exhibition of Industrial Films. 7 p.m.

Inst. of Metals: N. East Coast Local Section.—Joint meeting with Inst. of British Foundrymen, Armstrong College, Newcastle-upon-Tyne. "Addition of Non-ferrous Metals to Cast Iron," Mr. J. E. Hurst. 7.30 p.m.

Inst. of Petroleum Technologists.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Air Survey," Lieut. J. S. A. Salt. 5.30 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. "Liquid Crystals," Sir William Bragg, F.R.S. 5.15 p.m.

Sheffield Metallurgical Assoc.—198, West-street, Sheffield, 1. "Recent Progress in Refractories Development and Research," Mr. W. J. Rees. 7.30 p.m.

Societe des Ingenieurs Civils de France: British Section.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Presidential Address, "The Landing Stage of Le Verdon, Bordeaux," Mr. W. R. Howard. 6 p.m.

WEDNESDAY, DECEMBER 13TH.

Belfast Assoc. of Engineers.—Queen's Hotel, Belfast "Cement Manufacture," Mr. A. Tindal. 8 p.m.

Inst. of Civil Engineers.—Great George-street, S.W.1. Discussion, "The Control of the Generation of Electricity from a Large Number of Interconnected Stations to Obtain the Maximum Aggregate Efficiency," Mr. J. D. Peattie. 6 p.m.

Inst. of Engineers-in-Charge.—St. Bride Institute, Fleet-street, E.C.4. "Gas and Coke-fired Boilers for Central Heating and Domestic Water Heating," Mr. S. Adam. 7.30 p.m.

Inst. of Production Engineers: Coventry Section.—King's Head Hotel, Coventry. "The Control of Quality in Hardening and Heat Treatment Processes," Mr. H. H. Beeny. 7.30 p.m.

Inst. of Production Engineers: Luton Section.—Castle-street Hall, Luton. "Modern Methods of Inspection," Mr. M. C. Park. 7.30 p.m.

Inst. of Structural Engineers: Lancashire and Cheshire Branch.—At College of Technology, Manchester. "The Influence of Creep on the Modula Ratios and Working Stresses to be used in Reinforced Concrete," Dr. W. H. Glanville. 7 p.m.

Inst. of Welding Engineers.—At the Inst. of Mechanical Engineers, Storey's-gate, London, S.W.1. "Pressure Booster Installations for Acetylene Distribution for Welding," Mr. C. S. Milne. 7.45 p.m.

Newcomen Soc.—At Science Museum, S.W.7. "Charles Babbage and his Difference Engines," Mr. L. H. Dudley Buxton. 5.30 p.m.

N. East Coast Inst. of Engineers and Shipbuilders: Graduates.—Bolbec Hall, Newcastle-upon-Tyne. "Safety in Factories," Mr. J. Leslie Hobson. 7.15 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "The Art Schools and Industry," Mr. Harold W. Sanderson, 8 p.m.

Soc. of Glass Technology: London Section.—At Old Bell Restaurant, Holborn. Annual dinner. 7 p.m.

Television Soc.—University College, Gower-street, W.C.1. "Electro-optics in Television," Mr. L. M. Myers. 7 p.m.

THURSDAY, DECEMBER 14TH.

Inst. of Civil Engineers: Birmingham and District Assoc.—Queen's Hotel, Birmingham. Annual dinner. Reception, 6.30 p.m.; dinner, 7 p.m.

Inst. of Engineering Inspection.—At Junior Inst. of Engineers, 39, Victoria-street, Westminster, London, S.W.1. "The Manufacture and Inspection of Taps," illustrated by exhibits, Mr. L. G. J. Henshaw and Mr. A. Downie. 5.30 p.m.

Inst. of Marine Engineers: Junior Section.—The Minories, E.C.3. Film display, I., "The River Tyne," II., "The World of Machinery at the Leipzig Engineering Fair." 7 p.m.

Inst. of Structural Engineers.—10, Upper Belgrave-street, S.W.1. "Rigid Frame Bridges in Reinforced Concrete," Mr. A. P. Mason. 6.30 p.m.

FRIDAY, DECEMBER 15TH.

Inst. of Chemistry.—30, Russell-square, W.C.1. Fifth S. M. Gluckstein Memorial Lecture. "The Chemist as a Directing Force in Industry," Dr. Herbert Levinstein. 8 p.m.

Inst. of Electrical Engineers: N. Eastern Centre.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 for 7.30 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Discussion, "Heat Transfer between Metal Pipes and a Stream of Air," Dr. Ezer Griffiths and Mr. J. W. Awbery. 6 p.m.

Inst. of Structural Engineers: Midland Counties Branch.—At James Watt Memorial Inst., Birmingham. Discussion on "Welded Structures," 7 p.m.

Inst. of Structural Engineers: Western Counties Branch.—At Merchant Venturers' Technical College, Bristol. "Reinforced Concrete Bridges," Mr. J. T. Gueritte. 7.15 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "General Principles Governing Cable Network, Design and Maintenance in Large Towns," Mr. E. W. Carline Day. 8.30 p.m.

N. East Coast Inst. of Engineers and Shipbuilders.—Mining Inst., Newcastle-upon-Tyne. "Modern Practice in Ships' Steering Gear," Messrs. W. J. Paulin and W. Spencer Paulin. 6 p.m.

Railway Club.—Broad-street Station Restaurant, E.C. Annual dinner.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse, "Industrial Research: A Business Man's View," Mr. Kenneth Lee. 9 p.m.

SATURDAY, DECEMBER 16TH.

Inst. of Electrical Engineers: N. Midland Students.—Visit to Messrs. Marshall, Kay and Marshall, Dewsbury. 3 p.m.

Inst. of Engineers-in-Charge.—Visit Express Dairy Company's Research Laboratories, Claremont-road, Cricklewood, N.W.2. 2.30 p.m.

Manchester Assoc. of Engineers.—At College of Technology, Manchester. Conversazione and dance. Reception 6.45 p.m.

Sheffield Metallurgical Assoc.—198, West-street, Sheffield. Young people's party. 3.30 p.m.

MONDAY, DECEMBER 18TH.

Inst. of Automobile Engineers.—At Inst. of Engineers and Shipbuilders, 39, Elmbank-crescent, Glasgow. "Technical Aspects of the Design of the 'Blue Bird' Racing Car," Mr. R. A. Railton. 7.30 p.m.

TUESDAY, DECEMBER 19TH.

Inst. of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow, C.2. "Mechanical Methods of Solution of Stresses in Frames," Dr. C. H. Lobban. 7.30 p.m.

WEDNESDAY, DECEMBER 20TH.

Inst. of Automobile Engineers.—At Engineers' Club, Albert-square, Manchester. "Repairs," Mr. J. Dent. 7 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—Gordon Restaurant, Gordon-street, Glasgow. Luncheon. 1 p.m.

A Seven-Day Journal

London's Newest Hotel.

The new Cumberland Hotel at Marble Arch, built for the service of J. Lyons and Co., Ltd., was visited by the King and Queen on Sunday last, and was officially opened on Tuesday, December 12th. Its construction was supervised by the owners' engineering and electrical engineering departments, and it is noteworthy not alone for its size and modern equipment, but for the engineering side, which contains many features of technical interest. In its structure there is one of the heaviest girders built by Dorman, Long and Co., Ltd., which has a span of 68ft., a width of 2ft. 4in., a depth of 10ft. 4in., and weighs close upon 100 tons. The total weight of the steelwork is over 17,000 tons. In order to meet the steam requirements of the hotel, including heating, cooking, and thermal storage, there are five Thompson dryback boilers, oil-fired on the Clyde system, which furnish steam at 205 lb. per square inch, which is reduced to 100 lb. and lower pressures for the various services. The air-conditioning and refrigerating plant, installed by the Carrier Engineering Company, Ltd., includes both steam turbine and electrically driven refrigerating compressors and fans. Hot water is stored in three large calorifiers, with a total capacity of 20,000 gallons. In addition to the main refrigerating compressor above referred to, there are a large number of smaller Hallmark compressors for domestic use. The engineering equipment of this modern hotel, comprising public rooms and 1000 bedrooms, is in every way comparable with that of a large liner.

Foreign Capital in Poland.

The President of Poland has just issued an ordinance to encourage private enterprise and stimulate the investment of further foreign capital in the development of the electrification of the country. According to the *Polska Gospodarcza* (the Official Economic Journal), at the beginning of 1933, there were in existence in Poland, twenty-two companies which had been formed for the purpose of carrying out electricity supply works, and in these companies the share of foreign capital amounted to 142,000,000 zlotys, or 75·5 per cent. of the aggregate share capital of these companies. The first place in this respect is occupied by Belgian capital, with 58·7 million zlotys. One of these companies—the Société d'Enterprises Electriques en Pologne, which has seven subsidiary supply companies in Poland—has just paid a dividend of 16 per cent. for the past year on a share capital of 40,000,000f. The second position from the capital investment point of view is held by Germany with 50,000,000 zlotys. France comes third with 17·2 million zlotys, Switzerland fourth with 8·1 millions, and England fifth with 6·2 millions, while the small balance is in the hands of other countries. Under the new ordinance the Government expresses the hope that foreign capitalists will now take a larger share than hitherto in the work of electrifying the country, and in this direction the State, under definite conditions, will grant facilities in the matter of taxation.

A New London Airport.

For some time past, Gatwick Aerodrome has been used as a reserve aerodrome in foggy weather. It is now to be extended with the object of making it a leading London commercial airport. A syndicate, headed by Mr. A. C. M. Jackaman, is in charge of the new development scheme, which, when completed, will make of the present aerodrome a high-speed airport capable of serving London in all weathers with the minimum of delay in the connections from the terminal aerodrome to Central London. It is pointed out in this connection that the Southern Railway electric train system will enable passengers to reach London in thirty-six minutes, which is quicker than is generally possible by road from Croydon, especially in foggy weather. The high-speed traffic will be catered for by providing a landing surface with a clear run of half a mile in any direction, while the aerodrome is to be equipped with beam wireless systems, including a wireless beacon with a vertical beam, which will operate in conjunction with exceptionally accurate altimeters in the aeroplanes, designed to read to within 10ft. The new aerodrome will be entirely devoted to commercial flying, and there will be no private flying club. The new buildings will include a control tower, and sheds for housing the machines. The Southern Railway Company's Gatwick racecourse station, which is particularly well laid out, adjoins the aerodrome.

Quay Extension at Newcastle.

On Monday, December 11th, Mr. Walter Runciman, President of the Board of Trade, officially opened a quay extension at Newcastle-upon-Tyne, which was begun in February, 1931, under the direction and control of the City Engineer and has now been completed at a cost of about £87,000. The new quay adds 870ft. to the existing structure and provides a water depth of 35ft. at low tide. The reinforced concrete superstructure has a width of 44ft. and the depth from quay deck to the dredged level is 52ft., sites being provided for transit sheds, railways, and roadways at the back of the quay. The double line of rails at the front and rear leaves 100ft. for the transit sheds, which are to be erected later. At the back of the quay is a 36ft. wide reinforced concrete road with a 5ft. footpath. The quay itself has been built for a distributed load of 10 cwt. per square foot, and a 30-ton electric travelling crane. The contractors for the reinforced concrete work, the laying of the railway and crane tracks, and other work were Robert McAlpine and Sons (Newcastle-on-Tyne), Ltd., with L. G. Mouchel and Partners, Ltd., of Westminster. The preliminary earthwork, the demolition of property, and similar activities gave employment to Corporation workers.

A New High-Speed Monoplane.

On Saturday, December 9th, in the course of demonstration flights of Airspeed Courier six-passenger monoplanes piloted by Sir Alan Cobham, Mr. A. L. T. Naish and Mr. Neville Slack, speeds ranging from 160 to 170 miles per hour were recorded. The new monoplane, which will shortly be demonstrated in this country, on the Continent, in South America, and in India, was designed by Messrs. H. E. Tiltman and S. Norway, of Airspeed, Ltd., Portsmouth, in order to meet the demand for a high-speed passenger-carrying machine which will be economical alike in running and maintenance costs. A feature of the design is the use of the patented "Retractor" undercarriage, which draws the wheels into recesses in the wings when in flight, and drops them into landing position when required. The operation only takes nine seconds to withdraw and 2½ seconds to drop the wheels and it is effected hydraulically. It is said to reduce head resistance and to add 30 to 35 miles per hour to the cruising speed of the machine. For overseas service a 260 B.H.P. Armstrong-Siddeley "Cheetah" engine, giving a top speed of 170 and a cruising speed of 150 miles per hour, is fitted, while for British flying conditions an Armstrong-Siddeley "Lynx" engine of 240 B.H.P. is used, giving a top speed of 160 and a cruising speed of 140 miles per hour. With either engine the landing speed is about 50 miles per hour. The main dimensions of the monoplane are :—Span, 47ft.; length, 28ft. 6in.; and height, 8ft. 9in. On Saturday the conditions were far from ideal, but a take-off of 120 yards with a climb to 10,000ft. in twelve minutes with a 3500 lb. load was recorded. The petrol consumption is about 10·5 gallons per hour and the normal range is 700 miles with 840 miles using a special gravity tank.

The Chemical Constitution of Coal.

A report No. 37, just issued by the Fuel Research Station of the Department of Scientific and Industrial Research, and obtainable from the Stationery Office, deals with the action of solvents on coal. It points out that although coal has been our most important asset for centuries, far too little is known about its chemical constitution. As long as coal was mainly utilised by burning it in its raw state a knowledge of its chemical constitution was not necessary. The outlook upon coal, however, the report points out, is rapidly changing. It is coming to be regarded no longer simply as a fuel, but as a raw material for the manufacture of coke, gas and oil, and innumerable chemical products. Looked at from this point of view, a more complete knowledge of its chemical constitution is assuming increasing importance. Coal is so complex that precise information regarding its fundamental constitution is very difficult to obtain. The changes the coal substance undergoes under the application of heat or powerful reagents are usually so profound and complicated that only very limited conclusions can be drawn from these usual methods of chemical analysis. The most promising method appears to be that dealt with in the report, in which the coal substance is dissolved in a succession or combination of solvents in the hope of isolating definite identifiable chemical compounds. The report includes a complete summary of the whole and widely scattered literature relating to the action of solvents on coal—the experimental results and conclusions contained in it being in most cases set out in some detail. A description is also given of hydrogenation experiments on coals carried out with the object of gaining information on the constitution of coal and a better understanding of the mechanism of the hydrogenation process.

Road and Rail.

The introductory report which has recently been submitted by the Committee of Independent Experts to the International Chamber of Commerce draws attention to the international importance of the road and rail problem and emphasises the need for uniformity in the methods employed in attacking it in the various countries. It deals in the first part with the relationships between the State and railways and the State and motor transport, and concludes that unrestricted competition would inevitably lead to a loss all round. The case of a re-established monopoly of road transport is then discussed and is followed by an examination of possible methods of dealing with the road and rail problem. These are divided into three categories : firstly, a complete monopolisation of both forms of transport in a single organisation ; secondly, a system of competitive monopolies ; and thirdly, a system of co-ordinated competition. The Committee does not make any recommendations as to the adoption of one or other of the alternatives reviewed beyond general agreement on the impossibility of a system of unrestricted competition. It believes rather that for the present it has fulfilled its mission by studying objectively and submitting for consideration the different policies which are being or might be adopted.

The Flow of Thames Water.

According to a statement made by Lord Desborough at the Thames Conservancy meeting, held on Monday, December 11th, the flow of water in the river Thames was smaller in November and early December than it has been for twelve years. The average flow for last month measured at Teddington was 539 million gallons, compared with the normal rate of 1486 million gallons. Since the end of November the flow has still further decreased, reaching an average of 400 million gallons a day, against the normal December flow of 2073 million gallons. From official sources it is stated that a good deal of rain will still be required to fill up the chalk springs, and the widespread frost is greatly restricting the flow of surface water all over the Thames basin. Although the flow is seriously reduced, there seems to be no likelihood of a shortage of water within the London area. The Metropolitan Water Board is drawing about 180 million gallons of water from the Thames above Teddington daily and the Board's storage reservoirs are well filled, while the linked-up pipe lines of the Board have enabled it to supply East London adequately in spite of the failure of the Lea River.

Tramp Shipping.

At the end of last week two important pronouncements on the state of British shipping were made. The Council of the Chamber of Shipping passed a resolution setting forth its agreement with the report of the Tramp Shipping Committee with regard to the causes of the present position, and recommended that the Government be asked to grant a temporary subsidy with the object of equalising the advantages of foreign competitors secured by subsidies, depreciated currencies, and lower wage costs. The Council urged the grant of a temporary subsidy which would cost about £3,000 000 per year. It was further recommended by the Council that the Government should be asked to intensify its efforts to promote a trade group of nations willing to trade on a reciprocal basis of equality of treatment, but that defensive measures should not be overlooked, A memorandum issued by the Liverpool Steamship Owners' Association endorses the view of the Chamber of Shipping that a temporary subsidy might receive the consideration of the Government, but the Association remains opposed to measures of flag discrimination and reservation in the coasting inter-Empire and world trades, believing that such measures would defeat the maintenance of the British merchant navy, which primarily depends on the restoration of the world's trade. In the course of a speech made in Newcastle-upon-Tyne on Monday last, December 11th, Mr. Walter Runciman referred to the Chamber of Shipping appeal. While assuring those present that the Government would lend a ready ear, he expressed the hope that those who were to investigate the position would not work on the assumption that a simple way out of the difficulty was to be found in subsidies.

New Shipbuilding Orders.

Several orders, both for large and small ships, have been placed within the last few days. The Blue Star Line, Ltd., has placed with Harland and Wolff, Ltd., orders for two 515ft., 12,000-ton deadweight carrying capacity, refrigerated cargo ships for its New Zealand services. The ships will be propelled by ten-cylinder, four-stroke, Harland-B. & W., motors designed to give a speed of about 16 knots. On the Clyde, Scott's Shipbuilding and Engineering Company, Ltd., of Greenock, is to build a passenger and cargo motorship for London owners, Smaller ships include three motor-driven ferry boats for Clyde service to be built by Barclay, Curle and Co., Ltd., and engined by Glennifer Engines, Ltd, A motor tug for War Office target-towing service is to be built by Harland and Wolff, Ltd,, at Govan, and engined at the company's Finnieston works. The most important order of the week was undoubtedly the placing of the new Orient liner with Vickers-Armstrongs, Ltd., of Barrow-in-Furness, The new steamer will be a development of the design of the "Orontes," the latest 20,000-ton liner built by Vickers-Armstrongs for the Orient Steam Navigation Company, Ltd., and will be slightly larger than that ship.

Vertical-Lift Drawbridges.

By E. E. R. TRATMAN.

No. II.

(Concluded from page 564, December 8th.)

Lever-operated Lift Bridges.

In the first article only cable operation of lift bridges was considered, except that the quoted statement by Mr. Hovey contained mention of "mechanical links." Lift bridges in which cables are dispensed with are of interest for their operating features, but only a few bridges of this type have been built. The general arrangement is that on each tower is mounted a pair of pivoted trusses acting as horizontal rocking levers or "walking beams." Their outer ends are connected to the trusses of the lift, while the rear or shore ends carry counterweights.

In the Strobel design, the levers are normally tilted downwards, with their outer ends connected directly to the lift span by pivot pins. To compensate for the forward horizontal movement of the end of each lever, caused by its radial or circular path of travel, the connecting pin is carried in a roller which rides against the bottom of a short beam above the chord of the truss. An alternative arrangement is to provide horizontal travel for the trunnion bearings on the top of the tower, so that the bearing rolls back as the lever swings upward and the connection of lever to truss has thus a practically vertical path. In the Strauss design, the rocking levers have ordinary fixed trunnion bearings, but the levers are connected to the lift span through the medium of vertical links or hangers. These are pivoted to the levers and to the lift span, and their movement compensates for the lateral movement or swing of the levers.

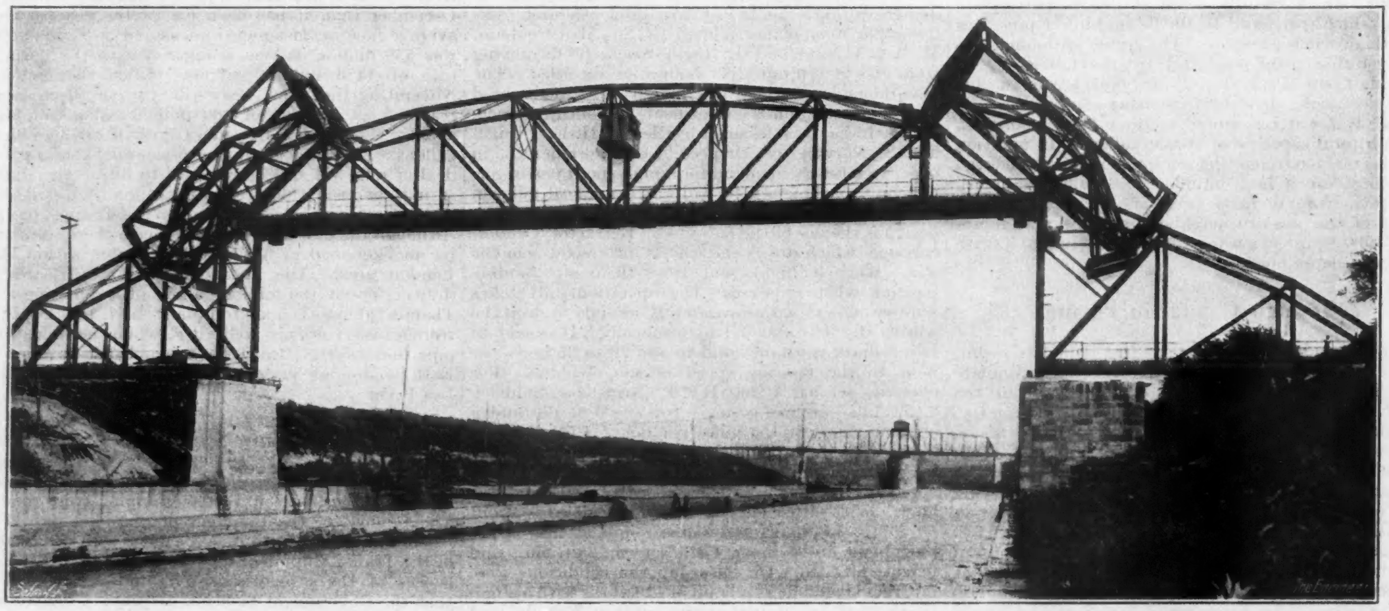


Fig. 9—Lever-Operated Lift Bridge, Louisville, U.S.A.

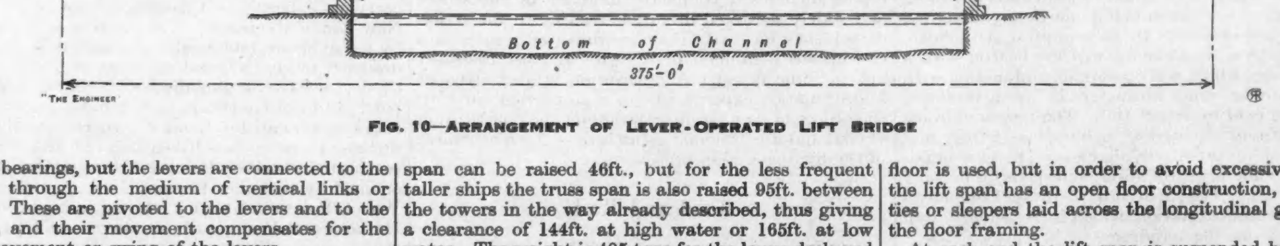


Fig. 10—Arrangement of Lever-Operated Lift Bridge

Both the Strobel and Strauss designs have the same method of operation, a power-driven pinion at each corner of the lift span gearing with a vertical rack on the face or the outer side of the column of the tower. A typical design, shown in Figs. 9 and 10, is a road bridge of the Strauss pattern built across the canal at Louisville, U.S.A. This bridge has a span of 210ft. and a vertical travel of 40ft. In a modification of the Strauss design the levers are eliminated and the lift span is suspended by cables in the usual way. There are, however, no operating cables, motor-driven pinions on extensions of the bottom chords of the trusses gearing with vertical racks on the tower posts. This arrangement is used on a 259ft. lift span of the highway bridge over the Illinois River at Pekin, U.S.A.

Multiple-lift Bridges.

A special application of the cable-operated lift bridge system is for double-decked bridges. A highway viaduct at Kansas City crosses the Missouri River by a high-level fixed span 428ft. long, of the through truss type. From this is suspended a 750-ton lower deck for railway lines at the ground level. This deck can be pulled up 43ft. above its normal position, or to the bottom of the fixed high-level span, giving a clear headway of 65ft. above the water. A bridge over the Willamette River at Portland has a 220ft. through truss lift span carrying a railway line, and below this is suspended a highway bridge which gives normally a headroom of 5ft. at high water or 26ft. at low water. To accommodate small craft the highway span can be raised 46ft., but for the less frequent taller ships the truss span is also raised 95ft. between the towers in the way already described, thus giving a clearance of 144ft. at high water or 165ft. at low water. The weight is 485 tons for the lower deck and 1900 tons for the truss span, a total of 2385 tons.

In both these bridges the method of raising the lower deck embodies the multiple-cable arrangement devised by Mr. Whipple some sixty years ago for his Erie Canal bridges, already mentioned. The lower span is simply a deck or floor framing, having at each panel point a hanger rod which telescopes in the corresponding post of the truss span above. When the deck is in its lowered position live load is taken by pins in the tops of the hanger rods, these pins being seated in saddles in the bottom chord of the truss and locked against vertical movement. Two cables attached to the top of each hanger pass up through the truss posts to sheaves in the upper part of the truss span, thence horizontally to the ends of the span, under guide sheaves at the ends, and up the towers to the head sheaves and counterweights. Each panel point is counterweighted independently.

Operation is effected by applying power through gearing to the guide sheaves at the ends of the truss span. For the operation of the upper or truss span in the Portland bridge the system is similar to that of ordinary vertical-lift bridges, as illustrated in Fig. 7 (*ante*) and already described.

Hackensack River Bridge.

To come back to the more typical cable-operated lift bridges, a specific example is the Hackensack River Bridge of the Delaware, Lackawanna and Western Railroad, shown in Fig. 11. Here the lift span is 198ft. long between end bearings, and its towers form short flanking spans of 85ft., instead of being built upon longer approach spans, as in many other bridges of this type. These towers are 168ft. high from top of pier to centre of cable sheaves, and the bridge has a vertical travel of 100ft., giving a maximum clearance of 140ft. The operator's house is in one of the towers, while the machinery house is at the centre of the lift span, above the railway lines. The bridge carries three lines of rails, spaced 13ft. between centres, and the trusses are therefore spaced 45ft. between centres. On the fixed spans a concrete floor is used, but in order to avoid excessive weight the lift span has an open floor construction, with the ties or sleepers laid across the longitudinal girders of the floor framing.

At each end the lift span is suspended by thirty-two cables, sixteen at each corner. These cables are of plough steel, 2in. in diameter, with an ultimate strength of 298,000 lb. per square inch. They are attached to transverse lifting girders riveted between the vertical end posts of the trusses. Threaded eyebolts in the attachments provide for the adjustment of length of individual cables, as shown in Fig. 12.

At the tops of the towers the cables pass over sheaves 13ft. in diameter and thence down to the two 610-ton counterweights.

Electrically operated gearing in the machinery house drives four drums, two on each side, as in Figs. 3 (*ante*) and 11, from which the 1in. operating cables lead to both ends of the span. There are two up-haul and two down-haul cables in each direction on each side of the bridge, making a total of sixteen operating cables. Their ultimate strength is 81,000 lb. From the guide sheaves at the ends of the span the up-haul cables lead vertically up to the projecting platforms at the tops of the towers, where they are coupled to threaded eyebolts which provide for adjustment of length. Similarly, the down-haul cables lead vertically downward to adjustable attachments or take-ups at the feet of the towers. These cables, attachments, and take-ups are shown in Fig. 12. Indicators in the operating house are connected to the moving span by ¾in. phosphor-bronze tiller ropes.

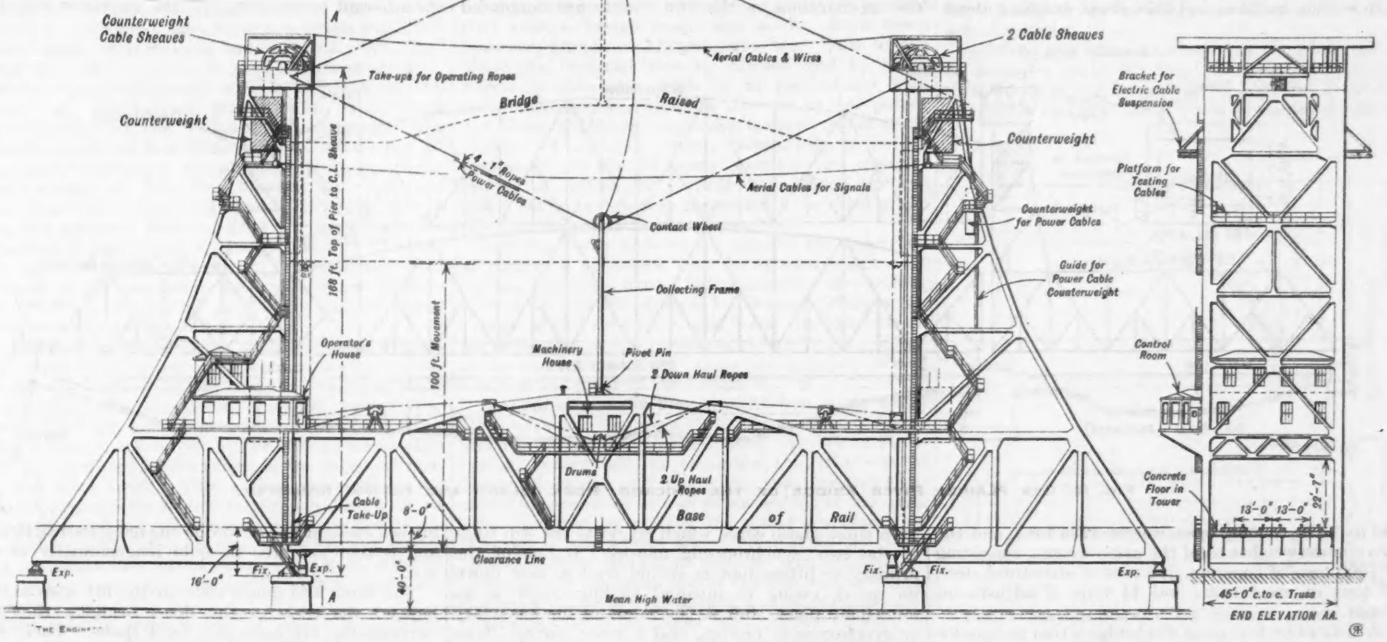

Counterweight Cable Sheaves
A
Take-ups for Operating Ropes
Aerial Cables & Wires
Bridge
Raised
2 Cable Sheaves
Counterweight
Counterweight
6-1" Ropes
Power Cables
Aerial Cables for Signals
Contact Wheel
168 ft. Top of Pier to C.L. Sheave
Collecting Frame
100 ft. Movement
Operator's House
Machinery House
Pivot Pin
2 Down Haul Ropes
Drums
2 Up Haul Ropes
Base of Rail
Cable Take-Up
6'-0"
40'-0"
Clearance Line
Exp.
Fix.
Exp.
16'-0"
Mean High Water
Fix.
Fix.
Exp.
A
"The Engineer"
Bracket for Electric Cable Suspension
Platform for Testing Cables
Counterweight for Power Cables
Guide for Power Cable Counterweight
Control Room
Concrete Floor in Tower
13'-0"
13'-0"
22'-7"
45'-0" c. to c. Truss
END ELEVATION AA.

FIG. 11—HACKENSACK RIVER BRIDGE ON THE DELAWARE, LACKAWANNA AND WESTERN RAILROAD

Current for the motors is taken from 1in. cables suspended between the tops of the towers, the connection being made by a vertical rocking frame or pantograph pivoted on the roof of the machinery house. The cables are attached to one tower, pass under a contact sheave on the rocking frame, and then over sheaves in the opposite tower, where they are connected to small counterweights, as shown in Fig. 11. The pivoting of the frame permits it to swing freely as the contact sheaves ride on the cables in the opening and closing of the bridge. Cables for signals and other purposes are suspended from brackets on the sides of the towers, as indicated on the end elevation in Fig. 11.

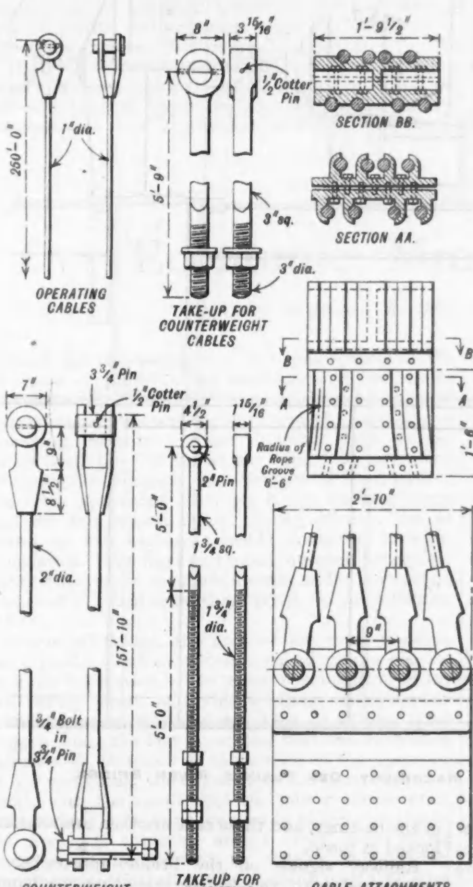

250'-0"
1" dia.
OPERATING CABLES
8"
3 15/16"
1½" Cotter Pin
5'-9"
3" sq.
3" dia.
TAKE-UP FOR COUNTERWEIGHT CABLES
1'-9½"
SECTION BB.
SECTION AA.
B
B
A
A
Radius of Rope Groove 6'-6"
1'-6"
7"
3¾" Pin
½" Cotter Pin
4½"
1 15/16"
9"
8½"
2" dia.
2" Pin
5'-0"
1¾" sq.
1⅜" dia.
157'-10"
5'-0"
2'-10"
9"
¾" Bolt in 3¾" Pin
COUNTERWEIGHT CABLES
TAKE-UP FOR OPERATING CABLES
CABLE ATTACHMENTS TO COUNTERWEIGHTS
"The Engineer"

FIG. 12—CABLE ATTACHMENTS OF HACKENSACK RIVER BRIDGE

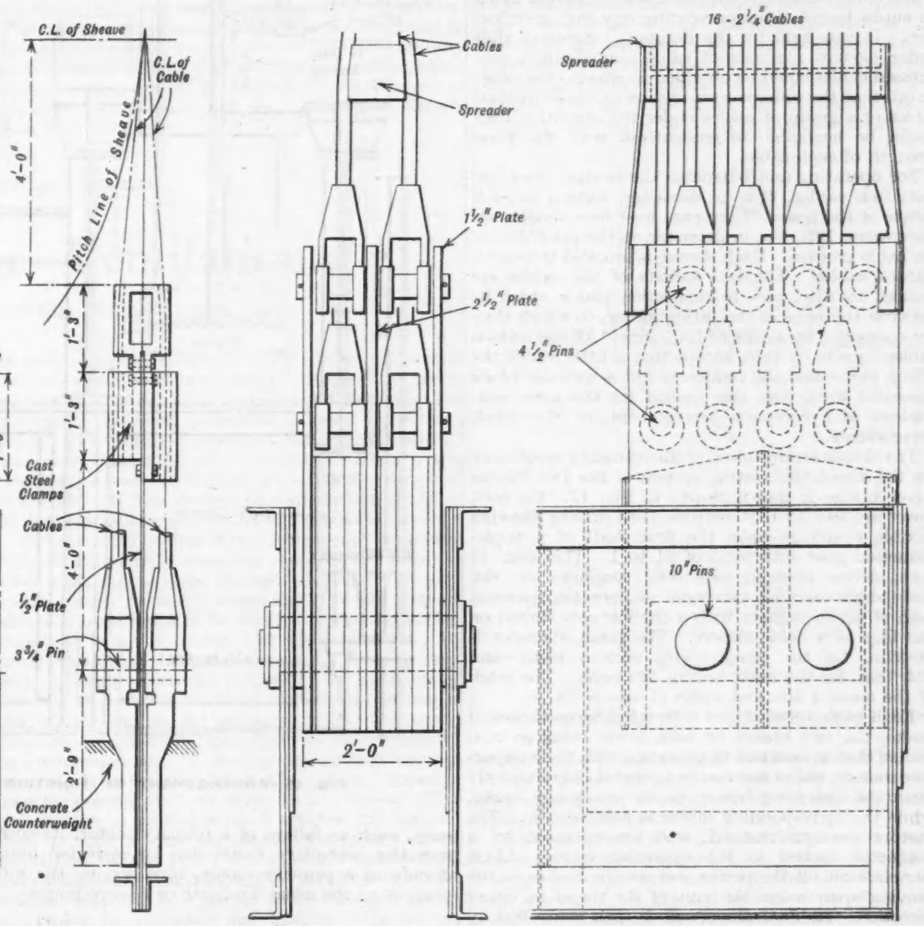

C.L. of Sheave
C.L. of Cable
Pitch Line of Sheave
4'-0"
1'-3"
1'-3"
1'-6"
Cast Steel Clamps
Cables
½" Plate
3¾" Pin
4'-0"
2'-9"
Concrete Counterweight
Cables
Spreader
1½" Plate
2½" Plate
4½" Pins
2'-0"
16 - 2¼" Cables
Spreader
10" Pins
"The Engineer"

FIG. 13—CABLE ATTACHMENTS TO COUNTERWEIGHT—DES PLAINES RIVER BRIDGE

DES PLAINES RIVER BRIDGE.

In the bridge of the Chicago, Rock Island and Pacific Railroad over the Des Plaines River, at Joliet (Fig. 14), the hoisting arrangement is of the direct-lift type, the suspension or counterweight cables serving also as operating cables by the application of power to the head sheaves on the towers. This system was first used in the White River bridge in 1927, as noted already. Owing to a skew of 38 deg. 46 min., the length of span in the Des Plaines River bridge is 298ft. 9in. between end bearings to give a clear width of 152ft. between the piers. The towers are built as integral parts of the approach truss spans, 100ft. and 150ft. long. At present the height of lift is 50ft., but as a greater clearance above the water may be required later, the towers are so designed as to permit of separating them from the upper chords of the trusses, the tower proper being then raised by jacking and supported while two additional bays, each 25ft. high, are built upon the trusses. In this way the height of lift will be increased to 100ft.

As in the Hackensack River bridge, the cables are attached to lifting girders between the end posts of the trusses of the lift span, as indicated by the end elevation in Fig. 14. These are double-web plate girders, each web being a ½in. plate 6ft. deep, with an outside flange angle, 6in. by 6in. at top and bottom. A similar girder forms the top of the steel frame of each counterweight, as shown in Fig. 13. This frame or box is filled with and embedded in concrete, and has pockets for blocks to adjust the weight. These blocks are of concrete loaded with steel punchings. Each is 15in. by 20in. and 13in. deep, weighing about 440 lb. The moving span weighs 1235 tons, and the two counterweights total the same weight, consisting of 1000 tons of concrete, 116 tons of structural steel, 75 tons of steel rails, and 44 tons of adjustment blocks.

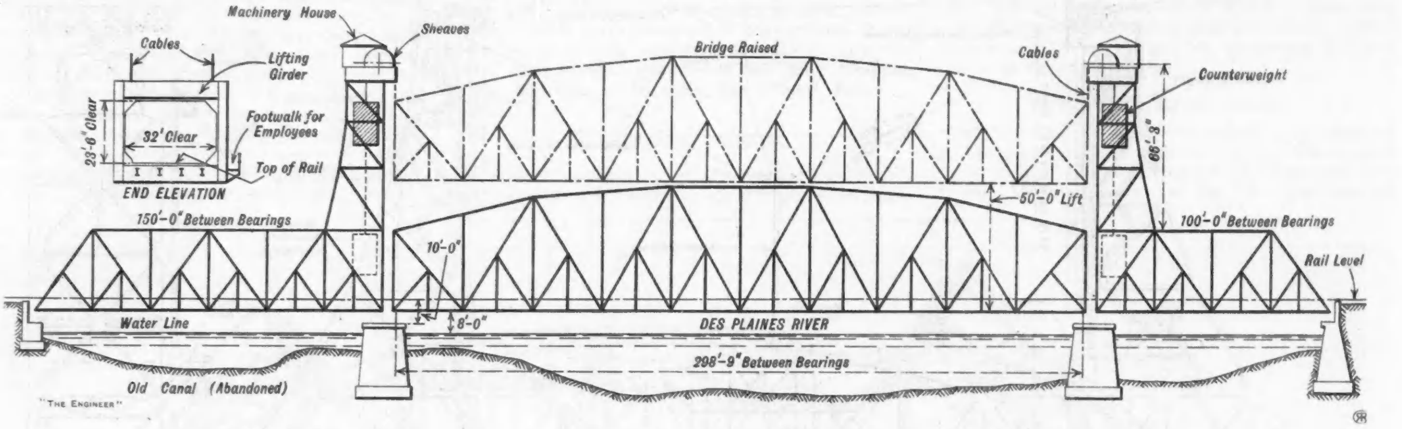


FIG. 14—DES PLAINES RIVER BRIDGE OF THE CHICAGO, ROCK ISLAND AND PACIFIC RAILROAD

A distinctive feature of this bridge is that no equalising device is used to maintain uniform loads on the cables. As a rule, groups of cables have been attached to equalising beams, which, in turn, are connected to the lifting girders or the counterweights by a single pin for each group. The hydraulic equalising device already described is expensive, though effective in operation. For the Des Plaines River bridge, all the cables were cut to exact length while subject to a stress equal to 2 per cent. of the ultimate strength. While being measured, the cable was supported along its entire length, thus preventing any sag or deflection. It was held by the designing engineers that under modern methods of cable manufacture, prestressed cables could be obtained so close to the exact length that the difference in tension in the individual cables of a group of cables under full operating load would be negligible in comparison with the total strength of each cable.

For operating and balancing the bridge, there are sixty-four cables, 2¼in. in diameter, sixteen at each corner of the span. They pass over four sheaves on the towers, 12ft. 9in. in diameter on the pitch line of the cable grooves. Each sheave is grooved to receive sixteen cables. The end sockets of the cables are secured by 4½in. pins to connection plates which lie between the webs of the lifting girder, to which they are connected by a pair of 10in. pins. All the sixteen cables lie side by side, except that a little above the lifting girder and the counterweight a spreader block separates them into two groups for the more convenient and compact arrangement of the cable attachments.

The simple arrangement of the operating machinery for the direct-lift hoisting system of the Des Plaines River bridge is shown clearly in Fig. 15. On each tower are two 75 H.P. motors, both driving through flexible couplings upon the first shaft of a triple-reduction gear with ratio of 91 to 1. This gear, in turn, drives through cast steel couplings an 8in. main shaft carrying two main or operating pinions, each of which engages with a circular rack bolted on the face of a cable sheave. The pitch diameter is 20·37in. for the pinion—with sixteen teeth—and 152·78in. for the rack, having 120 teeth. The pitch of the teeth is 4in. and width of face is 7in.

Each motor is equipped with a full-torque solenoid brake, the two brakes on each tower being so connected that in addition to operating with their respective motors, either one can be operated independently from the operating house, as an emergency brake, while the corresponding motor is running idle. The motors are synchronised, and are operated by a magnetic control in the operating house. Limit switches cut off the power and set the brakes as the moving span nears the end of its travel in either direction. Its final movement is then controlled by a separate switch that provides only a low power. The power equipment is designed to raise the bridge 50ft. in 105 seconds. Current is delivered by a cable laid in the bed of the river.

ELECTRIC CONTROL OF LIFT BRIDGES.

In the Des Plaines River bridge above described and in the Missouri River bridge of the Missouri, Kansas and Texas Railroad, synchronising equipment is used to maintain the lift span automatically level during its movements up and down. In other bridges a manually operated levelling device is employed. Where electric power is used it is general practice to provide two motors on each tower, one being operated normally and the other providing for reserve or emergency. But in these two bridges a special feature is the synchronising of the motors. On each tower, both the primary motor and the secondary or synchronising motor are connected to the main train of gearing, as described, the latter motor being driven against its normal phase rotation. The mechanisms on the two towers are connected by a three-phase cable which connects the slip rings of the two synchronising motors. If one of the primary or lifting motors should tend to slow down its speed, owing to unequal loading, there is an immediate phase shift in the rotors of the secondary or synchronising motors, and a rotor current flows from the one tending to run at the higher speed to produce torque in the other tending to run at lower speed. This prevents any change in the average speed of the two primary motors. In case of emergency, such as failure of a primary motor, its corresponding secondary motor can be corrected immediately as a primary motor, thus serving the same purpose as the usual duplicate or reserve motor.

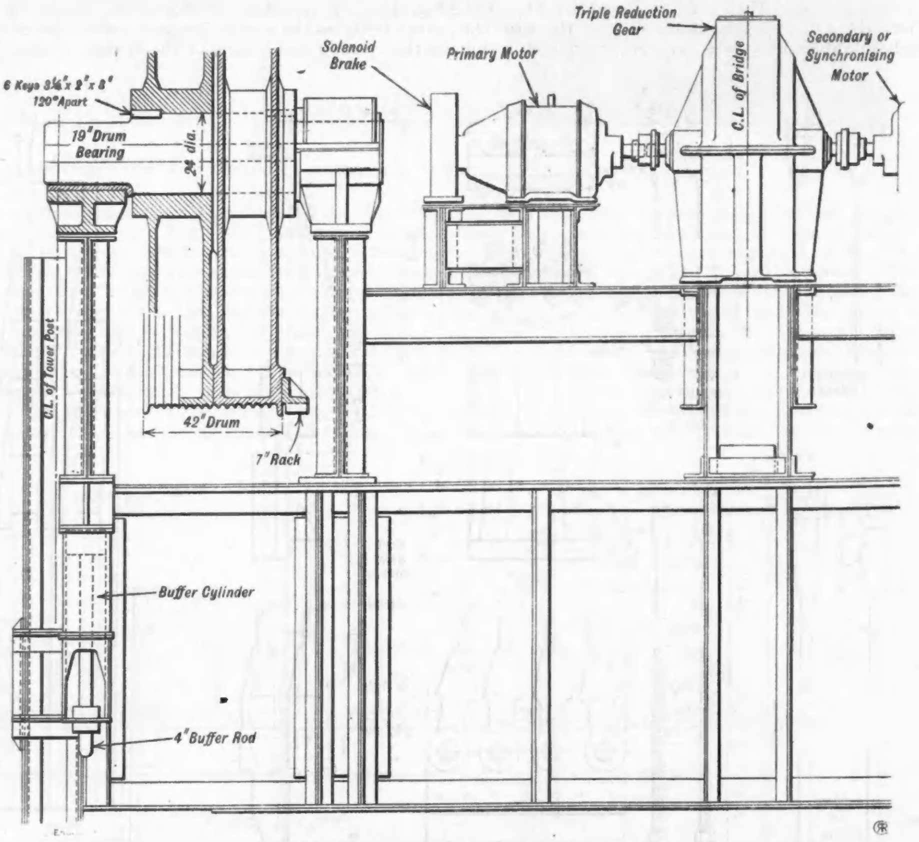


FIG. 15—ARRANGEMENT OF HOISTING MACHINERY—DES PLAINES RIVER BRIDGE

BRIDGE LOCKS AND SIGNALS.

At the end of its travel, either up or down, the span is brought to rest gently by means of air buffers. In rising, the bridge chords engage the plungers of four inverted cylinders carried by the head frames of the towers. In lowering, as shown in Fig. 15, the plungers of similar cylinders, 12in. diameter and 24in. stroke, attached to the bottoms of the end floor beams, engage striking plates on the tops of the masonry piers. The guide wheel arrangement, which steadies the span when moving, has been described already.

Centre locks of the bolt or plunger type on the ends of the lift span engage attachments on the end floor beams of the tower spans, thus insuring that the bridge is at the proper alignment and level. In the Des Plaines River bridge above described, the bottom chords of the lift span are locked with those of the tower spans when the bridge is closed. At the fixed end a T-headed lug at the end of each chord of the lift span engages a T-shaped socket on the chord of the adjacent tower span. At the expansion end, the lug is a straight bar or torque engaging a straight slot, and is therefore free to slide longitudinally in the slot.

The track and guard rails on the lift span extend beyond the ends of the floor, bridging the gaps between the lift span and fixed spans. Their ends are tapered, and as the bridge lowers, they seat against the sides of the tapered ends of the fixed rails, which are secured in steel castings. Inclined guides bring the moving rails into proper position in the castings, and these rails are then automatically locked in place.

Railway signals on the bridge approaches are interlocked with the bridge operating mechanism, and are repeated in the machinery house by indicators. In this house, also, other devices indicate the position of the bridge when moving and the positions of all locking mechanisms. Miniature lamp signals indicate when all the four corners of the span are fully seated on their bearings and the bridge is in position to carry trains. Before the span can be raised, the operator must set the signals against trains on both approaches. Until he does so he cannot release the end locks which hold the span in place. He must then energise the bridge interlock relay, thus permitting power to be applied to the bridge control mechanism. The same mechanism also prevents any change being made in the railway signals.

Tracks on Lift Bridges.

On the railway bridges, different arrangements of tracks are used. In almost all cases the floor is of open construction, with the rails seated on base plates on ties—or sleepers—resting on the longitudinal girders of the floor framing. On the Boonville Bridge, the flat-bottom rails are secured in heavy cast steel chairs by means of bolted clips, on the system of the latest standard track of the German railways. As a rule, also, there is a guard rail a few inches inside each running rail, and a timber guard along the ends of the ties to hold them in position.

Some of the bridges are on single-track lines, and others on double-track lines. The Hackensack River bridge of the Delaware, Lackawanna and Western Railroad has three lines of rails. For its four-track main line crossing the Calumet River, near Chicago, the New York Central Railroad has a four-track lift bridge. But the four-track line of the Pennsylvania Railroad over the same river has twin double-track bridges, side by side. This railway also has a similar arrangement of twin double-track bridges on its four-track line crossing the Chicago River, this arrangement facilitating traffic during the construction of the bridges.

The Missouri River bridge of the Missouri, Kansas and Texas Railroad has a single track, but to provide for double-tracking of the line the bridge is made wide enough for gauntleting a second track. The rails will be 9in. apart, the centre line of each track being offset 4½in. from the centre of the bridge. The rails for each track, therefore, serve as guard rails for the other track. This arrangement avoids the greater expense for a double-track bridge, with its larger foundations, piers and superstructure, while it also avoids the complications of two sets of points and crossings and interlocking signals to connect the double-track line with a single track across the bridge.

This gauntlet arrangement of tracks is employed also on the Des Plaines River bridge of the Chicago, Rock Island and Pacific Railway, although this bridge carries a double-track main line. But at Joliet the railway goods yards and running sheds are on the opposite side of the river from the city, so that there are frequent shunting movements across the bridge in connection with local coal yards, goods stations, and factories. With the gauntleted tracks, the lines of rails used for such shunting service are independent of the main track rails, thus avoiding the expense of installing, operating, and maintaining sets of points and crossings, with the added complications of signals and interlocking plants.

Highway lift bridges have usually floors of light construction, in order to reduce the weight. But on the two Hudson River bridges mentioned a heavy concrete slab floor is provided, with correspondingly heavy steel floor framing, as the road carries a dense traffic and the bridges are designed to carry 20-ton motor trucks.

Designers of Lift Bridges.

Modern application and development of the vertical-lift type of drawbridge or movable bridge began in 1894 with the Halsted-street bridge over the Chicago River. This bridge was designed by Mr. J. A. L. Waddell, consulting engineer, and the design was adopted in the face of strong opposition by engineers and local authorities, who were positive that such a bridge would not work. Since then, however, numerous bridges have been built to Mr. Waddell's designs, both by himself and by other engineers associated with or in partnership with him. His system, which is covered by his patent and those of different engineers, is based on the triple system of cables, already described, in which machinery on the lift span operates two separate groups of cables for hauling the bridge up and down, while the span is suspended by a third group of cables attached to counterweights.

Rocking lever systems to operate the span and so eliminate all cables were introduced about 1912 by two engineers, acting independently—Mr. Charles L. Strobel and Mr. Joseph B. Strauss. Only a few bridges of this type have been built. In both designs the operation is by means of power-driven pinions at the four corners of the bridge and engaging vertical racks on the posts of the towers.

A more important development was made about 1926, when the engineers of the Chicago, Rock Island and Pacific Railway, in designing the White River bridge, determined to eliminate the two sets of operating cables and to utilise the counterweight cables for operation as well as suspension of the span. This was done by placing the power machinery on the tops of the towers and gearing it to the cable sheaves. This direct-lift method was opposed as impracticable by some bridge builders and electrical engineers. However, the railway's engineering department was sure of its ground and had the courage of its convictions. The plan was adhered to, therefore, and the bridge was built as designed, under the direction of Mr. W. H. Petersen, chief engineer, and Mr. I. L. Simmons, bridge engineer.

As this first direct-lift bridge was entirely successful, from both the practical and economic points of view, the system has been followed in several later bridges. It has advantages in simplicity and reduced cost, and in eliminating the complications arising from three separate groups of cables, and relieving the lift span from the weight of operating machinery. This direct-lift system is not covered by patents. To the engineering department of the same railway is due the further step of eliminating the complications of cable equaliser connections by the use of pre-stressed cables cut to exact length, as already described.

Economic Mine Ventilation.

By Chief Engineer M. SCHAEFER, Bochum, Germany.

Fans for the ventilation of mines belong to the class of mine-working machinery required to be in continuous operation. The constant presence of numerous persons underground and the necessity of removing firedamp or other dangerous gases, compel us to keep the "lungs of the mine" in perpetual motion. Consequently, fans frequently form part of the mine equipment involving heavy working costs, and for this reason many mining officials aim at obtaining the highest possible economy in mine ventilation. The ways and means adopted for achieving this aim are in the main known, and it is therefore proposed to touch upon them briefly in the following article.

Above all things, the area of the mine passages has a predominating influence on all points bearing on mine ventilation. The power consumption of the ventilating plant and the working costs depend primarily upon this factor. This is all the more evident when the fact is recalled that the depression increases or decreases as the square of the variation of the mine area, the capacity of the fan being constant, with the result that the power consumption and working costs vary practically in the same ratio. By increasing the mine area twofold, the working costs would be reduced to roughly one-quarter. Hence, every effort should be made to make the mine area as large as possible. By compounding several shafts to a common up-cast shaft, it has repeatedly been possible to augment the mine area very considerably. The area may frequently be increased to a smaller extent by reducing the resistances in the shaft; for instance, by substituting grids for the timber platforms, this applying chiefly to narrow shafts.

The action of the fan is a factor of hardly less importance in its bearing on the working costs. As long as the capacity and power consumption of the fans were within narrow limits, low efficiencies could be put up with. However, when the air volumes to be moved increased at a constant rate, and the power consumption rose in a considerable measure, low efficiencies involved considerable losses in working costs. By carefully designing all fan details in accordance with the results of exhaustive research, it was possible gradually to increase the efficiency very considerably. At the present day efficiencies of 75 to 80 per cent. and even more are of frequent occurrence.

The correct selection of the driving unit is likewise of great influence in economic respects, the selection always depending upon the special features of individual cases. In mines where steam power is available, the main point to be decided is whether preference is to be given to steam or electrical drive. By using steam as a driving medium, the working costs may in many cases be reduced very appreciably, notably by suitably utilising the exhaust steam of the driving engine, for instance, in mixed-pressure turbines, for generating the supply of electric current or compressed air. A saving in working costs is particularly noticeable when the exhaust steam is used for heating the feed water for the boilers. This will at once be evident when it is taken into account that in such a case an almost completely closed circulation of the heat of the steam is obtained, from which only that quantity is extracted which the machine converts into power, and which gets lost in the piping by radiation and leakage. By far the major part of the heat is, however, returned to the boilers with the feed water.

Electrical drive should be chiefly selected only for shafts used purely for ventilating purposes, steam power being rarely available at shafts of this description.

Amongst the variety of measures adopted for obtaining efficient working conditions, mention may here be made of the use of cascade motors for plants of an extensive nature.

The position of the fan relative to the shaft, to the boiler plant, to the point of consumption of the waste steam, &c., should likewise be carefully considered if economic drawbacks are to be avoided. The proportioning and manner of laying out the intake conduit on the surface and connecting it with the shaft and fan can effect its total resistance very considerably, and even influence the efficiency of the fan.

An advantageous arrangement of a single and double-inlet fan, and a favourable airway designed to give the most satisfactory results, are shown in Figs. 1 and 2, the arrangement being derived from actual practice.

Efficient attendance and care of the plant will at all times be worth the cost. As a matter of course, the interior of the fan should be kept free from dirt, the volute casing cleared of water, the most suitable lubricating oils used, overhauling done in good time, and the efficiency tested at regular intervals.

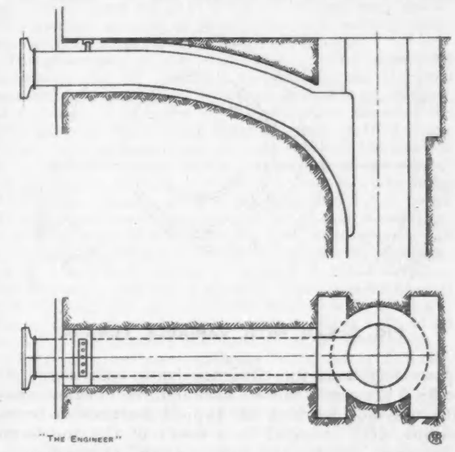


Fig. 1—Arrangement of Single Inlet Fan

Fan Design.

The aforesaid ways and means will, however, only suffice for obtaining or maintaining the highest economy, provided a further condition is fulfilled at the same time—the fan must at all times be suitable for the mine area. Experience has proved, however, that this requirement is in many cases not met, and the explanation is not difficult to account for. Owing to the advance in the mine workings, the airways are liable to constant variations, this involving variation of their resistance or of the equivalent mine orifice. On the other hand, the passages of a fan designed according to current practice remain unaltered. As a consequence, disagreement in a more or less marked degree is bound to follow on the necessary constant agreement; if, indeed, agreement had existed at the outset.

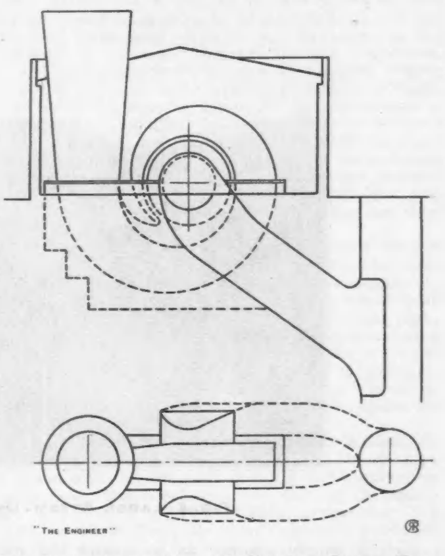


Fig. 2—Arrangement of Double Inlet Fan

The results are known. If the mine area increases, the period is soon reached when the air capacity of the fan no longer increases at the same ratio as the area increases. A gradual falling off in the manometric effect and efficiency is discernible. If the mine area decreases, a reduction of the proportionality is revealed, and in this case the efficiency is constantly lowered. Ultimately a pumping action of the fan is set up, causing shocks in the casing and chimney, or vibrations of the shaft which may become so serious that the reliability in working is endangered. In some cases the fan may emit a humming noise.

Among the numerous tests available, it is proposed to give two examples which clearly show the drawbacks of faulty agreement.

A double-inlet electrically driven suction fan, having a capacity of 350,000 cubic feet per minute, which from the outset ran at full speed, revealed a very strong pumping action when first put into operation. It could not be used for continuous service until over 150,000 cubic feet per minute of fresh air had been admitted into the fan intake conduit. This caused the working costs to rise by roughly 30,000 gold marks per year. Subsequent examination revealed the fact that, owing to unforeseen circumstances, the mine area at the time was very much smaller than had been estimated in advance by the mine officials, and on which the design of the fan had been based. It is proposed to refer to this case later.

A single-inlet suction fan, having a capacity of 247,000 cubic feet per minute, designed for a mine area of 23·7 square feet was tested at a capacity of 201,500 cubic feet per minute, the area being 36·4 square feet, and the efficiency being ascertained to be 58·5 per cent. Hence, although the normal capacity was not reached, all typical features of overloading were revealed as a result of the too large mine area. Neither the volume of air nor the depression were in the correct ratio to the revolutions or to the increase in the size of the mine area, and the power consumption was too high. The volume of air should have been about 12 per cent. higher, and the depression 24 per cent. higher, the efficiency should have been not less than 73 per cent. The extra consumption of current was calculated to be roughly 360,000 kW per year. If the fan had been working at its full capacity, the current consumption would have been almost twice the amount.

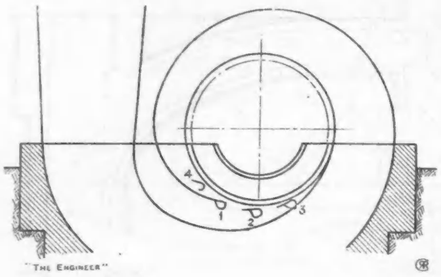


FIG. 3—FAN WITH VARIABLE TONGUE

CONTROLLED FAN PASSAGES.

A satisfactory elimination of such losses in working costs, frequently incurred for years, was first made possible by the introduction of a process which provides the means for influencing the fan passages in such a simple manner as to ensure the most favourable area of the passages for any capacity of the fan.

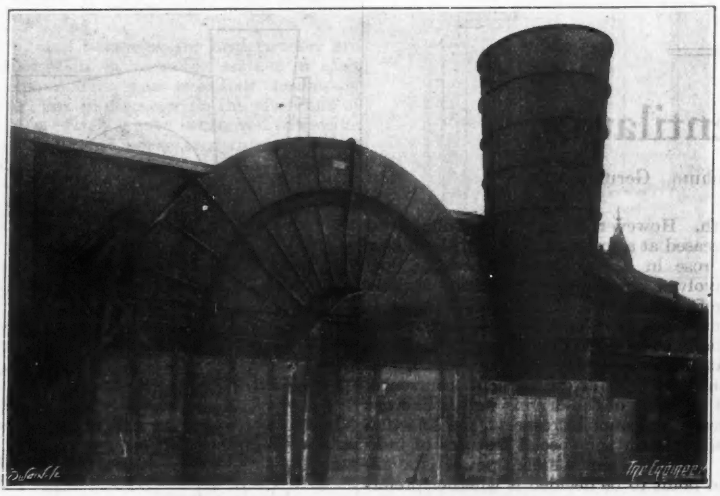


FIG. 4—LARGE STEAM-DRIVEN MINE VENTILATING FAN

The "area of the passages" of the fan is a conception similar to the "equivalent mine orifice." Hence, it would be more correct to say "equivalent area of the passages." Both represent a measure of the resistance to the passage of the air, on the one hand, through the fan passages, and, on the other hand, through the mine drifts. In the same manner as the lowest resistance denotes the greatest and economically most favourable mine area in the latter case, it signifies the greatest passage area and the best efficiency in the former case.

It will not be necessary to state the reason why the widest passages cannot always be considered identical with the greatest passage area. The proportioning of the passages results primarily from the constructional principles in each individual case, and remarkable differences may be encountered in various fan designs.

Now, whereas the size of the passages of the fan of a mine having a constant equivalent orifice remains constant from the lowest to the highest fan capacity, and *vice versâ*, it requires to be correspondingly rectified when the mine area is varied. In the process under consideration this is accomplished by shifting the position of the tongue in the fan casing.

It is still current practice to adhere strictly in other fan systems to the position once selected of the tongue of the volute. In a few fan types of older date the practice of shifting the tongue was adopted, but this was done for other purposes and does not in any way touch upon the principle of the process under consideration.

Fig. 3 represents various positions of the tongue by way of example. Let position 1 be the normal position, corresponding to a mine area of 32 square feet. As long as the latter remains unchanged, the position of the tongue is not altered for either lower or higher capacities of the fan. On the other hand, if the mine area is reduced, say, to 27 square feet, then the tongue is shifted to position 2, which would be fixed for this area. If the area is reduced still more, the tongue finally reaches the position 3, corresponding to an area of 21·5 square feet, &c. If the area is increased beyond 32 square feet, the tongue is moved, say, into the position 4, corresponding to an area of 38 square feet, and so forth.

By shifting the tongue in this manner, the possibility is given of influencing the passages to such a favourable degree that their total resistance is reduced to a minimum in each individual case, and the passages increased to a maximum. It is possible to attain an efficiency for each position of the tongue not lower than that of another fan specially designed for the corresponding mine area.

The successful results of the adjustment will be recognised from the following examples :—

(1) In the case of the previously mentioned double-inlet suction fan, with a capacity of 350,000 cubic feet per minute, the occasion presented itself of subsequently fitting the tongue adjusting device, with the result that the pumping action of the fan stopped immediately and the admission of outside air into the intake conduit was no longer needed. The fan then worked satisfactorily at its maximum speed and at about one-third of its maximum capacity, the hitherto incurred extra working costs being saved.

(2) A single-inlet electrically driven suction fan with a normal capacity of 212,000 cubic feet per minute was to be connected with an air shaft used till then as a downcast shaft. After a corresponding advance of the mine workings, a mine area of 32·3 square feet was selected for this volume of air. The initial area was difficult to foresee, and it was estimated, so far as this was possible, to be about 16·15 square feet. As will be evident from the following, it was at first still smaller. It was decided to build the fan for a normal mine area of 32·3 square feet, but to make it adjustable down to 16·15 square feet. The capacity was to be 106,000 cubic feet per minute for an area of 16·15 square feet and a speed of 245 r.p.m.

The fan was adjusted during erection for a mine area of 16·15 square feet, the following results being obtained at the test :—

R.p.m.	249
Cubic feet per minute	95,000
Depression	6·7in.
Input to motor	104 kW
or	141·5 H.P.
Air power of fan	101 H.P.
H.P. at the fan shaft at an efficiency of the motor of 92 per cent. and of the belt pull of 95 per cent.	123·5 H.P.
Equivalent mine orifice	14 sq. feet
Total efficiency	71·5 per cent.
Approximate efficiency of fan	82 per cent.

(3) A single-inlet suction fan of older date, originally provided for a capacity of 495,000 cubic feet at a mine area of 53·8 square feet, was to be so reconstructed that it constantly moved the greatest possible air volume at mine areas varying from 43·1 to 64·6 square feet and a constant speed of 225 r.p.m., and so that the flexibly coupled three-phase motor of 1500 horse-power was at all times fully loaded.

The following results were agreed to :—

Mine area, sq. feet.	R.p.m.	Capacity, cubic feet per min.	Depression, inches.
43·1	225	434,000	14·95
53·8	225	509,000	13·1
64·7	225	565,000	11·2

Provision was to be made to curtail the vanes of the fan wheel for dealing with areas greater than 43·1 square feet, so that the air capacity was correspondingly reduced and the motor not overloaded.

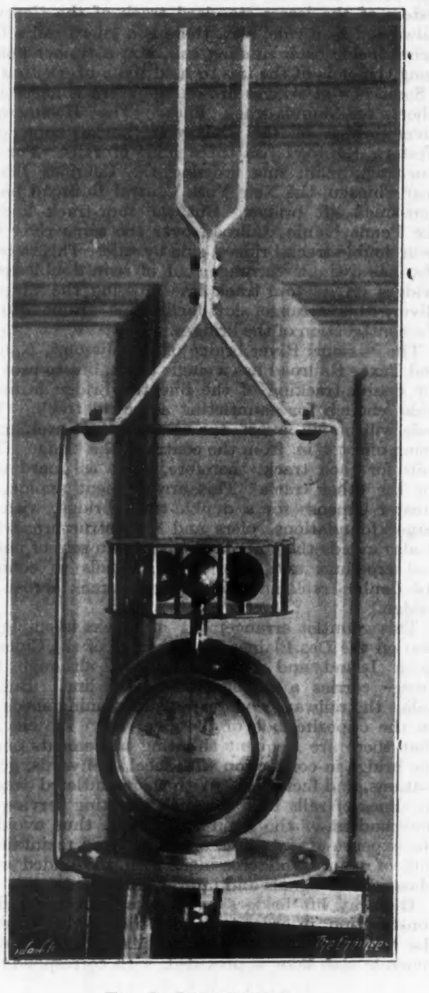


FIG. 5—ANEMOMETER

After reconstruction the fan was adjusted to 43·1 square feet, a larger area not being expected to be required for the time being. The results of the test carried out with the full length of the vanes were as follows :—

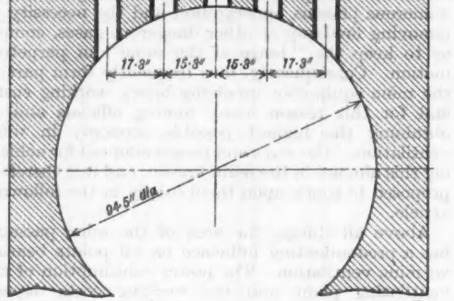


FIG. 6—MEASUREMENT POINTS

R.p.m.	227·25
Cubic feet per minute	431,000
Depression	16·05in.
Input to motor	1082 kW
or	1470 H.P.
Air power of fan	1105 H.P.
H.P. at fan shaft at an efficiency of the motor of 93 per cent.	1367 H.P.
Equivalent mine orifice	41·25 sq. feet
Total efficiency	75·2 per cent.
Efficiency of fan	80·86 per cent.

(4) An electrically driven fan of 282,000 cubic feet capacity was to be installed for increasing the ventilation of a main mine plant. As a result of an exhaustive estimation of profits, however, a fan*

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* The fan was supplied by Westfalia-Dinnendahl-Gröppel A.-G., of Bochum, Germany.

directly coupled to a single-cylinder superheated steam engine† was installed. The exhaust steam of the engine is used for preheating the boiler feed water, very economical working being thereby achieved in respect of heat expenditure.

In order to increase the mine area, two shafts were to be compounded to form one upcast shaft, and corresponding measures were to be taken underground. It was expected gradually to attain a mine area of about 34·4 square feet in this manner.

At first it appeared impossible to obtain an area slightly exceeding 16·2 square feet. Hence, the fan was to be made adjustable to a mine area of about 16·2 to 34·4 square feet. The best arrangement was obtained with a double-inlet fan. According to agreement, the fan was to run at a maximum speed of 135 r.p.m. Fig. 4 represents the fan.

In the course of erection the fan was adjusted to a mine area of about 16·2 square feet and tested, the following results being obtained :—

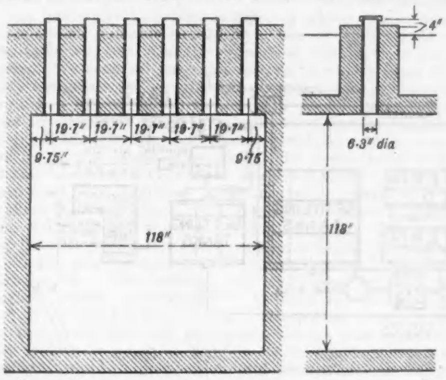

FIG. 7—MEASUREMENT POINTS

R.p.m.	129·2
Cubic feet per minute	295,000
Depression	10·08in.
Air power of fan	475 H.P.
Indicated power of steam engine	664 H.P.
Total efficiency of plant	71·5 per cent.
Equivalent mine orifice	35·64 sq. feet

The builders of the steam engine guaranteed a mechanical efficiency of 92 per cent. at 650 indicated horse-power. Actually, it seems to have been rather more. Taking it as 93 per cent., the efficiency of the fan worked out at roughly 76·88 per cent.

After the mine area had by calculation been ascertained to be 35·64 square feet by this test, the fan was adjusted to 34·4 square feet, and about four months later a new test was carried out, the results being as follows :—

R.p.m.	130·7
Cubic feet per minute	283,000
Depression	10·71in.
Air power of fan	484 H.P.
Indicated power of steam engine	624 H.P.
Total efficiency of plant	77·6 per cent.
Equivalent mine orifice	33·1 sq. feet

Taking an efficiency of 92·5 per cent. of the engine for the lower rate of indicated horse-power, the fan efficiency works out at 83·9 per cent., this representing an improvement on the previous efficiency of 9·13 per cent. brought about by the adjustment. The improvement on the depression is also worthy of note, this being attributed in a relatively small measure to the slightly higher speed.

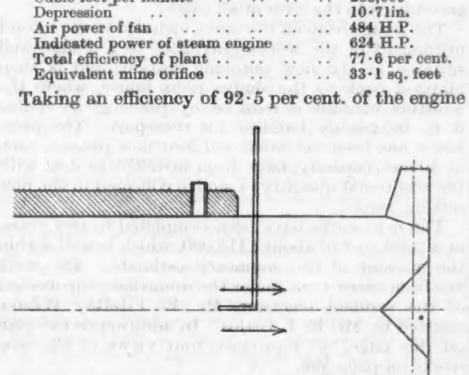

FIG. 8—POSITION OF PITOT TUBE

These tests were carried out when the mine was working at its full capacity. In a third test, instituted after the mine had been in operation about four months, and made when the mine was not working, the total efficiency of the plant was 77·7 per cent., the load being practically of equal magnitude.

It is a regrettable fact that, owing to the working conditions, the mine officials can seldom allow more than one test to be made under the working conditions prevailing at the moment. It goes without saying that a series of tests would be of general interest. Nevertheless, the above test results are sufficient proof of the advantageous behaviour of the adjustable fan under the working conditions in each individual case.

A few words may be added regarding the basis on which the tests were carried out.

BASIS OF THE TESTS.

All tests were made in accordance with the rules framed by the Verein deutscher Ingenieure for testing fans. The air volumes were measured by anemometers provided with cups fixed on a cross, these instruments being specially adapted for high velocities. These instruments are timed to run for three minutes, this period being automatically controlled by clockwork. The clockwork is enclosed in a casing of spherical form in order to eliminate faulty readings which are liable to occur in flattened clock cases. The cross with the cups works between two discs provided for guiding the air.

The instrument shown in Fig. 5 allows the readings to be taken correctly. The instruments were specially calibrated before and after each test by the Berggewerksschaftskasse, of Bochum.

Whilst the test (4) was being carried out, measurements were occasionally also taken by using a Prandtl tube. The results were in agreement with those obtained by the anemometer.

Figs. 6 and 7 show the points of measurement of the air for tests (2) and (4). The anemometers were secured in frames and moved evenly up and down by means of rods at each measuring point for about four to five minutes in each case. The mean velocity was thus ascertained on full measuring lines and not at single points of the area to be measured.

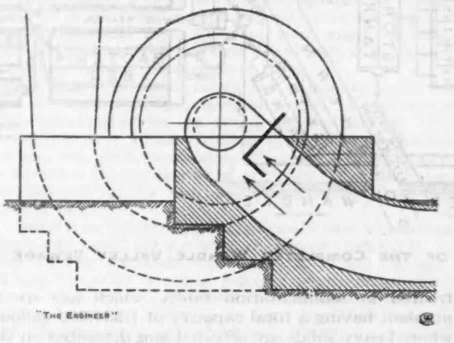

FIG. 9—POSITION OF PITOT TUBE

When anemometers are used with a frame as described they must be calibrated together with the frame.

The depression was ascertained close to the fan during the total duration of the tests at regular intervals by means of Pitot tubes, arranged as shown in Figs. 8 and 9, the reading representing the *total pressure*, and thus the static pressure less the velocity pressure, the mean pressure being inserted in the formula for calculating the air power. This simple method of measurement is, as a rule, preferable to the more complicated method of independently ascertaining the static pressure and velocity pressure.

The input of current to the motors was measured by calibrated current meters. The springs of the indicators were newly calibrated for every test, while the planimeters were tested as to their correct reading.

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† The engine was supplied by Gebr. Stork and Co., of Hengelo, Holland.

Electricity Supply, 1931–32.

THE Return of Engineering and Financial Statistics relating to Authorised Electricity Undertakings in Great Britain for the year ending March 31st, 1932, or May 15th, 1932, for public authority undertakings, and December 31st, 1931, for company undertakings has been issued by the Electricity Commissioners. Exclusive of new stations and extensions to existing stations which had been sanctioned but not brought to completion within the period covered by the return, the generating stations belonging to authorised undertakers in Great Britain, of which particulars are given, numbered 464. The total capacity of plant installed in the stations at the end of 1931–32 was 7,194,571 kW. Public authorities had 249 stations and companies 215 stations, with aggregate capacities of 4,665,160 and 2,529,411 kilowatts respectively.

The net addition to plant during the year amounted to 248,766 kW, as compared with 345,580 kW during the previous year. Of the total, 100,000 kW was accounted for by the coming into operation of the new Clarence Dock station of the Liverpool Corporation, a selected station for the purpose of the North-West England and North Wales Electricity Scheme. The 79 largest stations (20·9 per cent. of the total), each having an installed capacity of 25,000 kW or over, contained 5,612,667 kW of plant, or 78 per cent. of the total plant installed. Of the remaining 367 stations, 184 had an installed capacity of less than 1000 kW each.

As compared with the position at the end of 1930–31, there was an increase of 264,530 kW in the amount of steam turbine plant; a decrease of 16,135 kW in the amount of reciprocating steam plant; and an increase of 3026 kW of oil engine plant. A.C. plant represented 6,931,938 kW, or 96·35 per cent. of the total, and D.C. plant 262,633, or 3·6 per cent. During the year there was an increase of 263,798 kW in the amount of A.C. plant, and a decrease of 15,032 kW in the amount of D.C. plant. As much as 6,790,526 kW, or 94·38 per cent. of all the generating plant installed by authorised undertakers in Great Britain, consisted of steam turbo-alternators. There were 1197 A.C. units and 873 D.C. units with 161 and 125 kW rated capacities respectively. The D.C. plant comprised units having rated capacities ranging from 4 kW to 6000 kW, and the A.C. plant units from 10 kW to 50,000 kW; 250 A.C. units of 10,000 kW or over were installed in the generating stations of authorised undertakers, the aggregate capacity of the units in question amounting to 4,280,500 kW, and representing over 59 per cent. of the total capacity installed by all authorised undertakers.

One hundred and ninety-two stations generated A.C. only; 92 stations produced both A.C. and D.C.; and 180 stations D.C. only. Of the 284 stations at which A.C. was generated, in 196 cases a generation pressure of 6000 volts and upwards was adopted, either wholly or in part, a large majority of these cases representing three-phase, 50-cycle generation at 6600 volts. At 41 stations generation was carried out either wholly or in part at pressures of 10,000 volts or over. In 33 cases A.C. generation was carried out at voltages below 650, and in 60 other cases at voltages ranging between 1000 and 3000 volts. In the majority of cases the D.C. pressures ranged from 400 to 500 volts, but as many as 69 stations contained D.C. plant generating at pressures not exceeding 250 volts.

The generation of A.C. was carried out by authorised undertakers at 11 different frequencies, the accepted standard frequency of 50 cycles per second being the predominating one in vogue at 274 generating stations, the other principal frequencies being 25 cycles at 15 stations and 40 cycles at 11 stations. As compared with the position at the end of the year 1930–31, there was an increase of 437,380 kW in the amount of 50-cycle plant and a decrease of 173,582 kW in the amount of non-standard A.C. plant. The aggregate capacity of the 50-cycle plant installed at the end of 1931–32 was 5,918,281 kW, as compared with a total of 1,013,657 kW for all other frequencies, representing 85·4 and 14·6 per cent. for all A.C. plant installed. The predominating non-standard frequencies of 25 and 40 cycles together accounted for 942,550 kW, or 93 per cent. of the non-standard plant. Over 81 per cent. of all the A.C. plant installed was three-phase, 50-cycle plant.

The total evaporative capacity from and at 212 deg. Fah. of the boiler plant installed in all generating stations dealt with in the return was 81,683,651 lb. per hour, the figure for public supply authorities being 56,042,308 lb. per hour, and that for company stations 25,641,343 lb. per hour. The boiler plant was made up of 2405 units, having 166 differently rated evaporative capacities, ranging from 1500 lb. to 220,000 lb. per hour, and 48 different working pressures, ranging from 100 lb. to 475 lb. per square inch. The steam-raising plant in the generating station of the Bradford Corporation works at 1100 lb. per square inch.

Over 76 per cent. of the aggregate capacity in 1931–32 was accounted for by boilers having an hourly evaporative capacity of 30,000 lb. and upwards, as compared with 75 per cent. in the previous year and less than 30 per cent. in 1920–21. Boilers having a working pressure of less than 200 lb. per square inch represented under 16 per cent. of the aggregate boiler capacity in 1931–32, as compared with over 56 per cent. in 1920–21.

Excluding the Bournemouth Corporation, where supplies were given for public purposes only, the distribution system of the other 659 undertakings were A.C. in 269 cases, A.C. and D.C. in 286 cases, and D.C. only in 104 cases. While A.C. generation was carried out by authorised undertakers at 11 different frequencies, supplies of 12 different frequencies were distributed. In addition, a bulk supply at 30 cycles was obtained from a non-statutory source. At the end of 1931–32 supplies at two or more frequencies were being given by 23 undertakings, but in a number of these cases steps were being taken by the undertakers to eliminate the non-standard frequencies. Low and medium-pressure supplies at voltages, ranging from 100 to 480, were being given at 37 different voltages in the case of A.C. supplies and at 25 different voltages in the case of D.C. supplies, the total number of declared voltages within the range in question for both classes of supply taken collectively being 46, these figures including associated pairs of voltages. There were nine declared pressures exceeding 100 volts, but less than 200 volts, and 21 declared pressures exceeding 200 volts but less than 400 volts.

During 1931–32 public authorities generated 6905·6 million units and companies 4627·1 million units, compared with 6544·7 million and 4402·8 million respectively during 1930–31. The number of units generated in 1931–32 showed an increase of over 585 million, or 5·3 per cent., on the figures for 1930–31. The sales to consumers during the year showed an increase of 427 million units, or 4·7 per cent. on the figures for 1930–31. The number of consumers connected at the end of the year showed an increase of upwards of 634,000, or 15·8 per cent., on the figures for the previous year.

The requirements of the electricity supply industry in 1931–32 involved the consumption of over 8,736,000 tons of coal and coke, besides comparatively minor quantities of other fuel. Pulverised fuel was used by 20 undertakers to the extent of 1,055,318 tons, representing 12·1 per cent. of the total tonnage of coal and coke consumed during the year.

The progressive improvements in steam power station equipment and practice since 1920–21 have resulted in a reduction of the average fuel consumption per unit generated from 3·42 lb. in that year to 1·78 lb. in 1931–32. From the figures of the ratio of outputs per ton of fuel consumed given in the present and preceding returns, the conclusion may be drawn that technical developments have resulted in an all-round increase of 92 per cent. in the amount of electricity now obtainable per ton of fuel consumed at generating stations of authorised undertakers as a whole, as compared with the position in 1920–21.

THE Import Duties Advisory Committee gives notice of applications for an increase in the import duty on: Tools (except forks, shovels, spades, scythes, sickles, agricultural implements, screw taps and dies with ground threads and blow lamps for liquid fuel of pressure type), including domestic tools, but not including machine tools other than the separable cutting, drilling, screwing, milling, forming, and holding parts used in machinery or in machine tools, and parts thereof.

Wandle Valley Sewage Disposal.

The Wandle Valley Joint Sewerage Board was formed in 1916 in order to deal with the sewage from the constituent urban districts, which include Mitcham, Merton, Morden, Beddington, and Wallington. For many years sewage had been purified at the existing works near Byegrove-road, by treatment in sedimentation tanks, followed by contact beds, but at the time when the Board was formed these works had become totally inadequate and unsuitable for the efficient purification of the sewage from the population of the joint district.

The Board having decided to proceed with a comprehensive scheme of purification by more modern methods, including the provision of percolating filters to replace the old contact beds, the construction of the first instalment of this scheme was begun in 1922 and completed in 1925 at a cost of about £231,000. During the construction of these works the population had rapidly increased from 70,000 in 1922 to about 100,000 in 1925, and by 1929 had reached 115,000, the dry-weather flow of sewage being 4 million gallons per day, or about 25 per cent. in excess of the capacity of the first instalment of the works as designed. The principal reason for the exceptionally rapid increase of population was the development of building estates within the Board's area, particularly the London County Council estate at Morden, where houses had been erected to accommodate a population of about 25,000.

The Board was therefore compelled to provide for this rapid growth of the population, and in order to deal with the additional flow of sewage, it was decided in 1928 to proceed with the construction of the second instalment of the sewage disposal works. The Board therefore instructed Messrs. Willcox and Raikes, of Westminster and Birmingham, the engineers to the original scheme, to prepare the necessary detailed plans and estimates for submission to the Ministry of Health. These plans were duly approved by the Ministry and the loans sanctioned in April, 1931. The tender of William Moss and Sons, Ltd., of Loughborough, was eventually accepted for the whole of the structural work which was begun on November 9th, 1931.

The extensions have just been completed, and provide for treating an additional quantity of sewage amounting to 2 million gallons per day. This quantity necessitated the provision of new works of about two-thirds the capacity of the first instalment. The whole of the sewage is brought to the works by high-level and low-level systems of sewers, the high-level sewage being passed through screens with mechanical raking gear ; but as the low-level sewage is pumped by special " Stereophagus " pumps which break up all large solids, it is unncessary to install screens for this portion of the sewage flow. The sewage from the low-level system of sewers, together with about half of that from the high-level system, is treated on the first instalment of the works, and the remainder of the high-level sewage gravitates to a pump well at the new pumping station where pumping plant has been installed to raise the whole of the sewage for treatment by the second instalment of the works. It has been necessary to construct the tanks and bacteria beds included in the extensions above ground in the same manner as in the case of the first instalment, in order to provide sufficient fall to enable the final effluent to drain by gravitation to the main effluent conduit which discharges into the river Wandle at Western Pool.

The works included in the second instalment comprise the provision of screening plant, sewage and sludge pumping station, sedimentation tanks, bacteria beds and humus tanks, as well as storm water tanks and extensions of the arrangements and plant for sludge pressing. The plant installed at the pumping station includes six centrifugal pumps, three of which are required for raising crude sewage to the sedimentation tanks, and three for lifting storm water to the storm water tanks. There are also two vertical-spindle centrifugal pumps for pumping sludge back to the sludge-pressing house. The whole of the pumping plant is electrically driven, and automatically controlled by means of float switches, in order to ensure that the number of pumps in operation at any time will be in proper relation to the flow of sewage without the necessity of constant supervision by an attendent. Two Venturi meters and recorders are installed at the pumping station for measuring the quantity of sewage and storm water discharged by each set of pumps.

To meet the requirements of the Ministry of Health the sewage up to three times the dry-weather flow is treated in sedimentation tanks, which are six in number, having a total capacity of 1,334,000 gallons, where heavy solids are arrested and deposited on the floors in the form of sludge, which is removed at intervals and pumped back to the press house for treatment. After passing through these tanks the sewage still contains a percentage of light solids in suspension, together with colloidal matter, and in order to reduce the amount of this material before passing the effluent on to the filters, it is given a further period of settlement in six upward flow straining tanks, each measuring 18ft. by 18ft. by 17ft. deep, having a total capacity of 134,000 gallons. These tanks are of the Dortmund type with pyramidal bottoms. The inlet to each of them is so constructed that the sewage enters near the bottom. The solids settle in the lower part of each tank, while the liquid portion rises slowly to the surface, and is discharged over weirs into collecting channels.

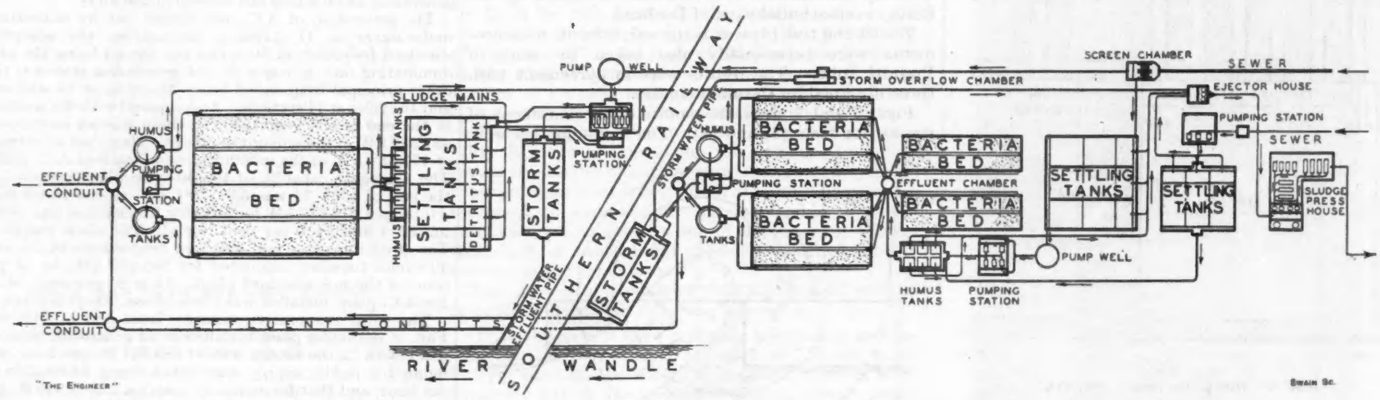
From these channels the tank effluent is discharged by gravitation to two rectangular bacteria beds, where the solids in solution and other polluting matters are converted into harmless compounds by bacterial action. These filter beds are constructed in two units each 720ft. long and 125ft. wide, their capacity being 32,650 cubic yards, and their total area 4 acres. In order to ensure a uniform rate of distribution of the tank effluent over the surface of the filtering material, the effluent is drawn from two feed troughs extending the whole length of each bed into travelling distributors, from which it is sprayed over the whole surface of the clinker, the distributors being automatically driven by wire ropes actuated by two small electric motors and reversing gear situated in motor houses at the end of the beds. Each motor is of 4 B.H.P., and operates six distributors, which are automatically controlled by switchgear in the pumping station, so that the number of distributors at work and the rate of treatment on the bacteria beds is always in accordance with the number of pumps in action and consequently with the rate of flow to the beds.

After passing through the filtering media which is 5ft. in depth, the purified effluent is collected by a system of under drains constructed in the concrete floors, and is discharged by main effluent channels into two humus tanks. These humus tanks consist of two circular upward flow tanks of the Dortmund type, having a total capacity of 134,000 gallons, and are intended to remove any flocculent or other matter which may have passed through or come from the filters. The final effluent from these tanks flows by gravitation through the main effluent conduit to Western Pool.

During wet weather when the rate of flow exceeds the volume that need be treated on the bacteria beds, viz., three times the dry-weather flow, the storm water is diverted by a storm overflow weir to the storm water tanks constructed in connection with the first instalment of the works. A new Venturi flume recorder has been installed to measure the quantity of water passing over this weir. As, however, these tanks are not large enough for the treatment of the whole of the storm water that may be discharged, two additional tanks with a total capacity of 500,000 gallons have been constructed to deal with the excess. The storm water is lifted into these tanks by the pumps previously referred to, which are arranged to start automatically as soon as the rate of flow is greater than can be efficiently treated in the storm water tanks provided in the first instalment. The new storm water tanks are situated close to the river Wandle, and have been constructed at such a level that the tank effluent can be discharged by gravitation to the river at all times.

The sludge from all the tanks included in the second instalment of the works gravitates to a sludge well situated at the new pumping station, and is then pumped back to the sludge press house, where the moisture content is reduced by pressing, to enable it to be readily handled for transport. The press house has been extended and four new presses, each of 30-cwt. capacity, have been installed to deal with the additional quantity of sludge collected in the new settling tanks.

The new works have been completed in two years, at a total cost of about £115,000, which is well within the amount of the engineers' estimate. The work has been carried out under the immediate supervision of the resident engineer, Mr. E. FitzRoy Wilson, assisted by Mr. E. J. Ettles. In addition to the plan on this page, we reproduce four views of the new works on page 596.



"The Engineer" Swain Sc.

General Plan of the Completed Wandle Valley Sewage Disposal Works

Credit in Industry.

By J. GIBSON JARVIE.

Ninety-nine per cent. of people do not understand credit. You have got to get into your minds exactly what credit is and to do so you have to go back a little in the history of this country. Credit can roughly be divided into two parts—credit for production and credit for distributive purposes, *i.e.*, credit for consumption. Credit for production has always been regarded as perfectly respectable. I am probably right in saying that most of you here to-day would not hesitate to take credit in making purchases of plant and raw materials, but there are perhaps some who would hesitate to extend credit to their customers. In the old days in England industrial society was mainly divided into two parts, employers and employees. The employers, to a considerable extent, were members of families established for generations, and the bulk of the profits went into their pockets. The employees got their wages, but they had no financial interest in the business. Then the joint stock company came into existence, but still that difference persisted. To-day, a great many public companies are controlled by people who do not own them. In many cases the employees are part owners. You can see for yourselves that in the early days of industry the question of credit had to be viewed from an entirely different standpoint. In those early days the merchants and manufacturers had credit and they used it very intelligently. But their workers did not have any credit. They paid cash and simply tightened their belts when times were bad and carried on. And in those days, demand always exceeded supply.

Coming now to the present day, an entirely new problem has arisen—distribution of the things we produce ; the need of credit for distribution, the need of credit for consumption purposes. And this because supply now exceeds demand. In the old days, distribution credit was not regarded as quite respectable, but there are more and more people beginning to realise that credit for distribution is a perfectly legitimate form of credit. That conclusion is being forced on them by the actual conditions with which we are faced to-day. In pre-war days our problem was production. In every manufacturing country demand exceeded supply. That position has

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[*] A luncheon address to the British Engineers' Association, on November 12th. The author is chairman and managing director of United Dominions Trust, Ltd.

been entirely reversed. The whole position is changed. It was being changed gradually, but the war made the change acute. Developments took place during the war that normally would have been carried on over thirty or forty years. Our problem is essentially a different one from the one before the war. It is the pre-war problem reversed. Production now scarcely concerns us. The bounty of Nature, science, better methods, mass production and native genius have combined to give us everything we can use or dream of using and we have not the knowledge of how to use them. That is why distribution credit has become so important a problem. I do not want to suggest that credit will solve all our problems. It will not. There are other questions and problems to be solved—tariffs for instance—and particularly in agriculture. There is the question of hours of labour.

Whether we like it or not hours of labour will have to come down and wages will have to go up. We are gradually approaching the point where the big division between employers and employees has got to be narrowed. In the old days the employers received the bulk of the profits from industry; that position must be altered. I am not suggesting that employers whose brains have built up an industry should have less of the rewards of the industry but that the employees will have to have more. We seem to have got beyond the time when the only ambition was to establish large fortunes and found families. In my youth in Scotland I can remember it was the desire of every man who went out to work so to build his own life that things would be a little easier for those who came after him. The great desire even of the labouring man was to leave his family and sons better off. To-day there is not the same incentive, nor is there the same reason; social conditions have changed. The economic position has entirely changed. The great gap between production and consumption must be bridged. It exists only because we have not the machinery for distribution. The system has not been adapted to modern needs. In principle it is fundamentally wrong, and to my mind it is a damnable thing, that there should be any restriction of production under the mistaken idea that it is going to help us to be wealthy. It is a perfectly childish proposition and should not be entertained for a moment. But it will have to be tolerated and entertained if business men do not get down to the fact that old methods have to be altered and the new facts faced.

We have to tune our minds to new ideas. The Macmillan Commission recognised that credit had become a very important thing, and the Report of the Commission speaks of the importance of utilising credit for consumption purposes. I insist that unless we wisely use credit we cannot recover. Credit alone will not bring prosperity, but it is a most important part of the equipment for recovery. If you use credit for production purposes you must logically use the same amount of credit for consumption purposes. That holds good now, though it did not before the war. Then, as I have said, demand exceeded supply; to-day, that is reversed. We have the means of production, greater production than ever before; new methods and conditions have given us that. If we have used credit to bring about this production we must use credit in order to distribute it. Credit is merely a means of exchanging one kind of wealth or service for another kind. It is nothing more than a tool, but it is a most important tool, and it must play a great part in the modern economic system.

There is one type of consumption credit which is perhaps more discussed than any other. For that reason, I shall speak of it. I refer to instalment selling or buying. In the company of which I am chairman, we have financed a large volume of this class of business. Quite frankly, we do it to make money, but also to establish certain principles. In discussing hire-purchase, at once the average man thinks of debt in the sense that it is an obligation on the part of a person who had no right to undertake the obligation. But he is probably quite wrong. If it were true, then the unwise use of hire-purchase would bring its own corrective. The people engaging in it and those financing them would make losses and eventually go out of business. After all, what is hire-purchase? It is merely a means of exchanging certain goods for certain other goods. That is all, and through hire-purchase there has been a lot of real wealth created in this country. During the last fourteen years we have financed the disposal of goods to the value of between £30,000,000 and £40,000,000. Most of these goods were not only durable, but productive in one sense or another. Definitely a great many have reproduced many other kinds of wealth. How, therefore, can anyone suggest that that is bad or that it is unsound business? It has done what we are all striving to do; it has increased business, wealth, and the amenities of life.

Credit is a most valuable tool for that purpose. I claim to have some experience of this, and my company's records of collections over that period show that the position has been so good that losses have not exceeded about one-tenth of 1 per cent. Does not that figure speak for itself? What has been the result? You have small people scattered all over the country who have now assets and capital goods they would not have had otherwise. Do not regard debt necessarily as a bad thing. I should regard my life as wasted from the commercial point of view if I could not incur obligations. The person who gets into debt to-day is usually a credit-worthy person, and the man who boasts that he "owes not any man" may be a debit to the country to-day. We cannot afford such men. If a man has credit and fails to use it wisely, then he is failing in some portion of his duty to himself and to the country. And the country in these times through which we are passing cannot afford that any asset, however small, shall lie idle. It is a perfectly logical statement. Hire-purchase is not a matter of some poor person getting a wireless set or a sewing machine; much the larger proportion of hire-purchase business concerns people whose credit standing cannot be questioned; people who have capital assets already, who own stocks and shares. It also concerns quite important kinds of merchandise. Hire-purchasers have credit, and they realise that it is easier to sell an investment—which they perhaps would have to do in order to make the desired purchase—than to replace it. They, therefore use their credit.

The point is that for every man and for every company there is a figure beyond which it is not convenient to draw a cheque; there is always a figure which is a man's or a company's maximum. But divide it into monthly or quarterly payments and it is an entirely different proposition. In the meantime, you have got the goods, and if they are productive goods, as they are in many cases, they may pay for themselves. I could quote endless cases where merchandise bought on this basis has within the time arranged for payment, paid for itself, and in the end the buyer has a capital asset standing at nothing in his balance sheet. That is very important. Some critics of hire-purchase, unthinking people, dear old ladies who deal with the big stores, and so on, say that hire-purchase is a dreadful business, a direct incitement to extravagance. They talk of encouraging the thriftless, and that sort of thing. Such people are responsible for a good deal of the ignorance on the subject, and they forget that often they owe their grocers, or butchers, or jewellers, money which is frequently overdue and uncollectable. They forget that spending may sometimes be wise and economy unwise.

I discussed this question once with a "cash" tailor. The average account on his books was outstanding eight or nine months. He had the names of people who had had suits for two years without paying. And yet there are people who would argue against this system for clothes! That tailor would be infinitely better off if he had sold on the instalment system. He could at least have budgeted his position. He would have been in a much healthier state financially. Again, I meet firms who say, "Why should I do it? It is undignified. If any of my customers come along I do not mind giving them credit." I would suggest to you, in your own companies, to take the trouble to examine your accounts over the last five years. Examine for yourselves how many of these supposedly thirty-day accounts have been paid on anything approaching the due date.

How many of these thirty-day customers have not paid for sixty or ninety days or more? Figure out a reasonable interest for the period involved and see what it has cost you, to say nothing of the fact that while the accounts were outstanding it was impossible for you to budget with any degree of accuracy. Far too many business men do not look into their accounts from this point of view.

I recall a certain firm making a certain class of machine which was suited for a system of deferred payments. I tried hard to persuade the chairman to sell on hire-purchase contract or on a deferred payments contract (there is an important difference between the two). I spent a long time in trying to show him that it was a perfectly good way of doing business. Finally, he promised that if any customer came along and asked for credit he would remember me. That was as far as I could persuade him to go. That did happen, and we put through one transaction. Within twelve months we handled a large volume of business for that concern. That chairman realised at least the value of organised credit, for most of that was additional business he would not have had otherwise. In every line of business there are potential customers who can pay if they are given time. Do not forget also that due to the diffidence which is characteristic of the British people, the man who is worthy of credit too seldom asks for it. It is the untrustworthy man who so blatantly asks for credit. You will always get the cash customer anyway, but if you "sell" on credit you will get a class of customer that you may not have now and whom you perhaps never will get unless you definitely sell on credit.

I am stating facts because I have compared the methods of different companies in the same line of business. One merchant or manufacturer sells on credit. He does not worry about the cash customer, but definitely offers credit, and he has a big business. Another man accepts a credit customer if he comes along, but does not seek credit business. The chances are he is doing a smaller business. One sees it constantly. In these days many companies in this country find it rather difficult to get along because of the bad years. Their capital is tied up, their assets are in a frozen condition. They could do business if they procured new equipment or plant. This is a type of concern where credit could be used. And credit can be extended to an almost unlimited amount if soundly conducted. There need be no undue risk in it at all. Every case must be considered on its merits. There is a tremendously big field, a wide open field, and British industry will not recover unless our merchants and manufacturers take advantage of it. Our people are diffident in seeking credit, so it must be offered. Do not merely give credit; offer credit.

Take the case of the United States of America. America is quoted as the classic example of the over-extension of credit. I will say right away, and I do not think informed criticism will contradict me, America has not overdone the credit system.

Quite recently I met a vice-president of a most important banking company in America, a company which finances hundreds of millions of dollars of credit business, and he told me about the troubles there and of these abnormal times. The experience of his company has been amazing—at least it seems so—in the circumstances. Repossessions of merchandise financed during the last twelve months are only one-fifth of the repossessions in the previous year. The collection record is at least as good as it has been over several years in spite of the times they are passing through. The company also had a large business in Germany, covering transactions in motor cars and machinery, with about 30 million Reichmarks outstanding a year or two ago. They decided to cut all their foreign entanglements, and they have liquidated to about 1 million outstanding to-day. The normal reserves they have set up are more than sufficient to take care of the losses. Even in Germany, therefore, in spite of conditions, the private German citizen and the small and large German company who bought on the instalment system have paid and are paying their debts normally. From 30 millions to less than 1 million in two or three years! I ask you to give these facts your serious consideration.

After all, money is merely a means of exchange; credit is the same thing only it is more elastic. It can give you bigger business and a better organised business financially, because it can be financed on what is, for all practical purposes, a cash basis for you. That is—credit for your customers, cash at once to you. You can procure a new class of customer and a sound class of customer. There is much business to be done if you will only seek it out and do it.

Napier (N.Z.) Harbour Development Scheme.

A big development scheme has been undertaken in connection with the Napier (Hawke's Bay, New Zealand) harbour scheme. The total expenditure on the complete programme adopted, which will take several years to carry out, amounts to £406,000, the interest and sinking fund for which can be provided from the Board's funds by adding 1s. per ton to the wharfage charges on all cargo (inwards and outwards) for a period of 4½ years, and without the necessity of striking a rate upon land over the harbour rating district. All work, wherever possible, will be on a contract basis, and the 200 to 300 workmen engaged over the period of the contract will be employed full time at standard award rates of pay.

It is confidently anticipated that, apart from the increased trade these facilities will attract, and the more efficient mode of handling Hawke's Bay export and import cargoes, the saving to the Board and the people of Hawke's Bay, once these facilities are provided, will amount to some £70,000 annually, which saving will be increased as wharfage charges are reduced and Napier is made a free port.

The intention is, subject to the approval of the Loans Board, to make, first, a commencement with loan moneys already authorised, by lowering the foreshore (raised 7ft. by the great earthquake of February, 1931), carrying out reclamation works, laying out a new railway yard, starting breakwater extension, and carrying out the necessary dredging for and the erecting of a new timber wharf.

This timber wharf is intended to take the lighterage traffic, and also coastal steamers, if desired, until such time as berthage for overseas vessels is provided, and will be 350ft. in length by 50ft. in width. It will be a substantial job, stiffened with raking piles, flush decked, and carrying four lines of rails. All piles will be sheathed in copper. Both sides will be dredged to 30ft. below low water, so that by later extending the wharf two admirable loading berths for overseas steamers will be provided.

The remainder of the scheme includes rather extensive dredging, the extension of the breakwater by at least 400ft. to afford the requisite shelter, and the erection of a large reinforced concrete wharf, complete with cargo sheds. Dredging will be carried down to a depth of 35ft. L.W.O.S.T. on each side of this latter wharf, thus providing berthage for two of the largest overseas vessels trading to New Zealand, and the structure itself will be 800ft. in length by 181ft. in width. The dimensions of each of the two wharf sheds will be 300ft. by 75ft.

As mentioned previously, the earthquake had the effect of raising the harbour bed by about 7ft., with the result that the deck of the Glasgow wharf is now 16½ft. above high water. The new wharves, however, will be built to a height of only 7ft. above high water level. The breakwater harbour has, through the raising of the breakwater and the formation of spending beaches around the foreshore, greatly benefited by the earthquake, in so far as range within the harbour is concerned, and offers far more secure berthage than heretofore, vessels now commonly tying up with their own lines. With added protection through breakwater extension, it should prove an excellent artificial harbour.

To carry out the above programme of works, the Board intends to raise the sum of £395,000, plus an additional amount of £11,700 for maintaining the Inner Harbour until such time as the first new wharf is built.

BOOKS OF REFERENCE.

Motor Ships of the World and Motor Shipping Register. Fourth issue, edited by A. C. Hardy. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street. Price 15s. net.—The fourth issue of this annual reference book of motor ships and oil-electrically propelled vessels, shows by its increased number of pages the large number of oil-engined ships which have been added to the merchant fleets of the world during the last eighteen months or so. While the handy arrangement has been retained, giving the name, owners, size, and particulars of main and auxiliary machinery for each ship, it has been possible to add a number of useful particulars which have been missing in earlier issues, and, with the co-operation of shipbuilders and engine makers, to bring all returns up to date. A useful feature of the book is the separate tabulation in the register of motor tankers, oil-electric ships, and motor ships with geared drive. The register, which now contains representative illustrations of modern motor ships, may be recommended to all interested in the progress of the motor ship. It definitely indicates a trend in the direction of large cargo liners, several of which have recently been placed in commission.

Minerals Year Book, 1932–33. Washington, U.S.A. 1933. Price 1·25 dollars.—This new year book is published to supersede the various publications issued from time to time by the Bureau of Mines, and the *Mineral Resources of the United States*, which has been issued annually for some fifty years. It contains some 800 pages and is divided into four sections. The first is a Review of the Mineral Industry, and is followed by "Metals," which includes a large number of tables and statistics of metals, their production, consumption, and, in most cases, their average yearly price in America and other countries. The metals dealt with include gold, silver, copper, lead, zinc, iron, mercury, manganese, tungsten, tin, radium, arsenic, &c. The third part of the volume deals with Non-Metals, including coal, petroleum, asphalte, stone, sand, clay, salt, talc, mica, &c. The book concludes with a section on mine safety.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RESEARCH ON STEELS FOR HIGH TEMPERATURES.

Sir,—I have read with great interest the leading article in last week's issue of your paper, and your report on a Conference recently held in London for the purpose of securing continued financial support for carrying on the valuable researches now in hand on steels and steel alloys suitable for higher temperatures.

I have for many years been an advocate for higher temperatures for steam power plants, believing that it is easier to raise the thermal efficiency by means of temperature than by increase of pressure. At a later stage research may enable us to increase both temperature and pressure, and gain still higher efficiency.

It was not difficult in the past to find sympathetic friends agreeing that the idea was good, but when it came to actually building a plant, no one would take a commercial risk without imposing impossible guarantees from the manufacturer. Here was a lack of co-operation, and development was retarded till five years ago when Mr. Alex Dow, president of the Detroit-Edison Company, U.S.A., came to the rescue by ordering from my company a 10,000-kW turbo-generator running at 3600 r.p.m. to operate at a steam pressure of 375 lb. and a steam temperature of 1000 deg. Fah. The turbine plant was duly designed and manufactured in Rugby and shipped to Detroit. The superheater was supplied by B. & W., New York, and is of the radiant type.

In designing the steam turbine for this relatively high temperature I was greatly assisted by the research work which had already been done by the B.E.A.I.R.A. Research Committee at the National Physical Laboratory, and our own tests in Rugby on the creep limit of various steels and steel alloys for temperatures up to 1100 deg. Fah.

It may interest your readers to know that this plant has been in commercial operation for the last two years, and for 8000 hours has been in operation with a load of 10,000 kW and steam temperature of 1000 deg. Fah. Obviously, some troubles were expected, and also encountered, at this high temperature; mostly caused by creep. On the whole, the troubles have been less than expected, and not of a deterring or serious nature, but confined to accessories.

Two papers are being read this week in New York before A.S.M.E. on this plant, one dealing with the various materials used in the construction of the plant, and the other one giving thermal performance. From the latter it will be seen that energy consumption in B.Th.U. per kW-hour is reduced from 11,600 at 700 deg. Fah. steam temperature to 10,700 at 1000 deg. Fah. steam temperature, or a gain of 7·75 per cent.

That the turbine efficiency is improved with the higher temperature is shown by the following figures:—

At 700 deg. Fah. steam temperature, combined turbine and heater efficiency, 76·7 per cent.

At 1000 deg. Fah. steam temperature, combined turbine and heater efficiency, 79·5 per cent.

—a gain of 3·6 per cent.

These test results may to-day be considered on the low side, but their relative values are important.

When the plant was designed, simplicity was aimed at; efficiency had to take second place to safety at the high temperature. These results are most encouraging and indicate that it will be worth while to carry on the research work now in progress at the National Physical Laboratory.

Frederick Samuelson.

B.T.H. Co., Ltd., Rugby,
December 6th.

POWER TRANSMISSION FROM NORWAY TO GERMANY.

A scheme for the electrical transmission of power from Norway to Germany has long been projected, and was discussed at the World Power Congress in Berlin a year or two ago. With the co-operation of the two leading electrical manufacturing firms in Germany, Swedish and Norwegian interests then formed a company under the title of the Norsk Kraftexport, A.S., for the purpose of studying the problem, and at the annual meeting of this company in Oslo on November 30th, when engineering representatives of the Berlin A.E.G. and the Siemens interests were also present, the question of Norwegian supply to Germany was raised in connection with an invention which has been devised by a Swedish engineer (Herr Baltazar von Platen). This engineer claims to have invented a machine for the long-distance transmission of energy by means of the use of very high-tension continuous current.

Herr Bernard Ell, chief engineer of a Swedish cable manufacturing works (Sieverts Kabelverk, of Sundbyberg), presented a report on the new machine at the meeting of the Kraftexport company. According to the *Goteborgs Handels och Sjofartstidning*, Herr Ell stated that the machine in question is constructed on the collector system, and the progress made with it has so far proceeded that it is now possible to build machines for high-pressure continuous current of a capacity of 60,000 kilowatts and a tension of 300,000 volts. On his part, Herr Ell submitted that there would be no difficulty in constructing cables for 500,000 volts for the proposed transmission of power from Norway to Germany, and expressed the opinion that the cables in the first place should be laid direct from Norway to Denmark as continuous-current cables. While there would be no difficulty in producing the necessary cables, he considered that difficulties would arise in laying them, and for this purpose a special ship would have to be built.

Canadian Engineering News.

(By our Canadian Correspondent.)

Montreal Water Level Problems.

Periodic drops of the harbour water levels to a low mark constitute a threat to Montreal's position as one of the world's first-class ports, and for that reason the study of this problem and of its most effective solution is being intensified in Federal Government circles. In the near future a 35ft. channel from Montreal to the sea will be completed, but this boon to St. Lawrence River navigation would be of little value if the safe movement of vessels to and from the berths in the harbour could not be assured. One of the anomalies of the present situation is that the very deepening of the channel to Montreal from the sea has to an extent aggravated the problem of water levels in Montreal Harbour. The deepening and the accompanying acceleration of water flow down the St. Lawrence from Montreal has obviously had an adverse influence upon levels in the harbour. The serious water level conditions during recent weeks has prompted those most deeply concerned to turn to the report of Sir Alexander Gibb, written two years ago, on Montreal's harbour facilities and the channel improvement down to the sea. After referring to the great dredging programme, now nearing completion, Sir Alexander Gibb had this to say about the channel and its relation to harbour levels at Montreal: "It is now clear that dredging of itself will not secure, except at prohibitive cost, a permanent and dependable 35ft. channel. I feel strongly that the problems of the St. Lawrence are too difficult, complicated, and far-reaching, and that its control and regulation will involve too many considerations and too heavy expenditure for it to be left either in the hands of one department or divided among a number." Since then the dredging programme has been almost completed, but a satisfactory solution of the problem of water levels in Montreal Harbour has not yet been found. As a result of the report of the Haskell Commission, made in 1915, a series of weirs or dams was built by the Department of Marine in the islands at Sorel and above that port. That work has had the effect of raising the level of the river at Sorel by 1½ft., and the Montreal Harbour level by at least 6in. This latter result, however, is far from solving Montreal's problem. Another plan proposed was the building of a dam or weir at the foot of Lake St. Peter. Still another called for a dam further down the river, and a third was the erection of some control works at the foot of Lake Ontario. All these schemes have been given study by Government officials and much valuable information has been gathered.

Municipalisation of Electricity.

Municipalisation of electricity in the province of Quebec, where power is wholly distributed by private companies, is now being widely discussed and the question is likely to develop into a spirited controversy at the next session of the Quebec Legislature. Already two municipalities, St. Hyacinthe and Quebec City, have decided to submit the matter to property owners in the form of referendums next January, and the question is also a live issue in Montreal, where a contract with the Montreal Light, Heat and Power Consolidated for the lighting of streets and public buildings will soon have to be renewed or rejected. During the last two sessions of the provincial Legislature, Government members have voted against the demand of the City of Quebec for authorisation to municipalise electric services. Since then, events have occurred which seem to show that the people favour more than ever the municipalisation movement. A group of Montreal members is preparing to ask the Government for the creation of an independent Commission to investigate the question, with instructions to report to the Legislature with suitable recommendations which could be acted upon before the end of the coming session. From the provincial point of view, the situation is complex, for while the cities and towns tend towards municipalisation, the rural sections clamour for an extension of electric transmission lines throughout the province, and companies distributing electricity claim that they cannot satisfy all the demands in the province, especially in sparsely populated communities, without a heavy loss.

St. Lawrence Channel Deepened.

Government engineers have completed part of the work of deepening and widening the North Traverse Channel, that section of the St. Lawrence to the east of the Island of Orleans. This waterway, which eliminates the more difficult section of the river known as the South Traverse, has been dredged to a depth of 32½ft. at low water, and provides a channel 500ft. in width. The completion of this further stage in the development of the St. Lawrence removes, therefore, another possible hazard to navigation. The ultimate objective for the North Traverse Channel is 35ft. at low water and a width of 1000ft. Dredging operations in this section of the river commenced as far back as 1911. Six years ago, on June 1st, 1927, the North Traverse Channel was declared available for navigation by vessels drawing down to 25½ft. at all stages of the tide, and by craft of deeper draught at all stages other than extreme low water. It was buoyed throughout its length, and all pilots were fully instructed on the aids to navigation. The project at that time was termed prodigious. In order to permit of ships drawing down to 30ft. to navigate the 10-mile stretch at all stages of the tide, it was necessary to remove an additional 550,000 cubic yards of material, while an estimate of 3,743,806 cubic yards was given as the amount that had to be dredged from the channel before a depth of 35ft. and a width of 500ft. could be attained. During the last season of navigation, two dredges worked 171 and 99 days respectively, completing and cleaning up the channel to a width of 500ft. They also commenced widening the "cut" to 1000ft. These craft removed 237,714 cubic yards on the 35ft. project, and 315,071 cubic yards of material were taken out in cleaning up the waterway. Figures for this season are not yet available. Government engineers state that a total of 127,135,808 cubic yards of material will have been removed from the ship channel between Montreal and the sea when the full 35ft. project has been completed.

Electric Railways.

The traffic of electric railways in Canada, which is composed largely of urban street car traffic, has been declining, and during 1932 five systems, including two inter-urban lines, ceased operation. One of these, the Brantford Municipal Railway, substituted an omnibus service for three months, but resumed operation again early in 1933. During the year 720,468,361 fare passengers were carried, which was a decrease from the 1931 traffic of 77,637,359 passengers, or 10·8 per cent. The greatest rate of decrease was on the small systems carrying less than two million passengers per annum. These showed a decrease of 29·1 per cent.

Cement-coated Nails.

Tests carried out at the Forest Products Laboratories of the Dominion Government have shown that cement-coated nails have from two to three times the holding power of similar types which have not been coated, depending on the density of the wood used. In woods of low density such as pine, basswood, and spruce, the ratio of holding power of the cement-coated nails is approximately three to one, while in heavier woods, such as birch and elm, the ratio is approximately two to one.

Nickel Production.

Finally revised statistics on nickel production in Canada in 1932 show an output of 30,327,968 lb., valued at 7,179,862 dollars, as compared with 65,666,320 lb., worth 15,267,453 dollars in 1931, and 103,768,857 lb., valued at 24,455,133 dollars in 1930. The 1932 production represents a decline of 53·8 per cent. in quantity, and 53 per cent. in value from the preceding year, and 70·8 per cent. in volume and 70·6 per cent. in value from 1930. During the first six months of the present year production of nickel amounted to 22,808,434 lb., as compared with 21,162,786 lb. for the corresponding period of 1932. The greatest improvement was shown in May and June of this year.

SIXTY YEARS AGO.

Quite recently it was hinted in pretty plain terms by a member of the Government that if the users of our roads did not of their own accord take effective action towards securing a reduction in the number of road accidents and fatalities the Government would be compelled to take drastic steps to enforce that end. The occasion is not one which justifies the adoption of a pharisaical attitude on the part of the railways, rightly proud though they may be of the relative safety which they offer the travelling public. If they feel tempted to express pious thanks that they are not as the roads, they should remind themselves that exactly sixty years ago they were in precisely the same position. There had been a rapid recurrence of numerous and fatal accidents on the railways. The public had become somewhat alarmed, and Mr. Chichester Fortescue, the Secretary to the Board of Trade, had addressed a circular letter to the companies, calling their attention to the facts. In that letter he urged that more caution in the working of the railways was desirable and hinted that unless his suggestions were acted upon the Government would very probably interfere to enforce steps designed to promote safer travelling. In a leading article on the subject in our issue of December 19th, 1873, we were hardly polite to Mr. Fortescue. His threat of Government interference was, we considered, an idle one, and amounted largely to "empty vapouring." Nevertheless we were equally severe with some of the companies over certain statements and lines of argument made and followed in their replies to Mr. Fortescue's letter. Mr. Laing, of the London and Brighton Company, and, to a lesser extent, Mr. Castleman, of the South-Western, had, we thought, made out good cases for their railways against the official criticism. Their replies stressed the fact—a fact which we fully accepted as true—that the railways in the South of England were almost exempt from casualties. It was easy, we thought, to see why the southern lines should be so happily situated in this respect. They had little goods or mineral traffic except light parcels for the Continent, and coal. Their trains ran nearly at a uniform speed and there was a minimum of shunting. They had few extended runs and they undoubtedly enjoyed the advantage of drawing their servants from the better educated population of the South. With the reply sent by Mr. Moon, of the London and North-Western, we expressed disagreement and discontent. He argued against the adoption of the continuous brake that it was still uncertain whether it was applicable to and would prove satisfactory on his company's 4000 passenger vehicles, and that in any event the rapidity of invention rendered it desirable to wait in order to see what improvements would be made. Mr. Castleman also opposed the adoption of the continuous brake on various grounds, the chief of which was that it would have a bad effect on the tires, wheels, axles, and rails. Our reply to these arguments was that, while it was necessary to exercise caution in the adoption of new inventions, a point could be reached at which caution degenerated into criminal cowardice. Mr. Moon and Mr. Castleman, in view of what had recently been done in the United States in the way of applying a system of continuous brakes—we were obviously referring to the Westinghouse system—were, we held, very much too cautious for the public good. Other points affecting the safety of railway operation with which we dealt were defective signalling systems and congestion of traffic. Very radical changes, we felt certain, would have to be introduced at no distant date. The most necessary of them all, we argued, was the doubling of the main lines in order that goods and passenger traffic might be worked on separate systems of permanent way. Not only safety, but the continued prosperity of the country, demanded that improvement.

Railway and Road Matters.

A traffic officer of the London, Midland and Scottish Railway, speaking at Holyhead last week, said that it was proposed to accelerate the Irish mail trains by fifteen minutes.

What, when introduced last May, were known as "summer" tickets, but which might equally and more fittingly be called return tickets, are to be continued during 1934. In making this fact known the railway companies intimate that the results have indicated the desirability of a longer experimental period.

We now learn that the railway and works in the urban district of Hazel Grove and Bromhall, mentioned herein on December 8th, in relation to the Bill deposited by the L.M.S. Railway, will join the Stockport and Buxton branch and the New Mills and Heaton Mersey main line. These lines cross each other on the west side of Stockport.

The "Royal Scot" train which toured Canada and the United States will be on exhibition at Euston Station over the present week-end. The engine and eight coaches will be thrown open to public inspection at No. 6 platform, Euston, from 3 p.m. to 10 p.m. on Friday (December 15th), 10 a.m. to 9.30 p.m. on Saturday, and 10 a.m. to 10 p.m. on Sunday (December 17th).

The landslide on the Cambrian coast, near Fairbourne, last March, and its sequel in a fatal railway accident, will be remembered. The Merioneth County Council proposes, as a consequence of that accident, to divert the road, but at a meeting of the Council on December 6th it was reported that the Ministry of Transport had refused to make a grant towards the work, and that the railway company had declined to rebuild and maintain the retaining wall. The facts were recorded in The Engineer of July 14th last.

The extensive alterations that have been made at Paddington Station, including the absorption of Bishop's-road, have led to the station being equipped with power signalling. There are three signal-boxes, Westbourne Bridge, Paddington Arrival, and Paddington Departure, which contain 88, 184, and 96 levers respectively. The frames have the interlocking electrically operated, as is now become the practice after eighty years' use of mechanical interlocking. The signal contractors were the General Railway Signal Company, Ltd.

On Tuesday, December 12th, the London, Midland and Scottish Railway announced that a works and rolling stock programme for 1934 had been authorised, which will involve an expenditure of no less than £8,400,000 on major replacements and improvements. The programme includes the construction of 232 locomotives and 159 locomotive boilers, together with 674 carriages and 5365 wagons. In addition, the company will renew 500 miles of permanent way, representing 80,000 tons of rails, all of which will be ordered from British steel manufacturers. The announcement of this large development programme follows the recent allocation by the L.M.S. of orders with British manufacturers for 100 new locomotives and 2000 freight wagons for express services, which was recorded in a Journal note of December 1st.

There were three serious railway accidents last week. On the evening of Wednesday, the 6th, an up fish train, running between Raskelf and Alne, on the London and North-Eastern Railway, north of York, caught up and collided with a goods train. The down main line was fouled as a consequence of the collision and the 4 p.m. express from King's Cross to Newcastle ran into the obstruction. There were no personal injuries. During a dense fog on the morning of Thursday, the 7th, an electrically operated passenger train, when entering Altrincham, M.S.J. Joint Railway, collided with a standing train. The driver of the arriving train was killed. On the evening of Friday, the 8th, a goods train was being shunted off the down line into a siding at Broadheath, L.M.S. Railway, when the 5.15 p.m. express from Manchester to Liverpool ran into it.

One of the economies in railway operation that war conditions compelled was the common use of wagons. When a wagon belonging to one company passed on to the line of another company the latter could not use it for any other purpose than for a load to the owning company, and frequently it had therefore to be returned empty. By the common use then introduced the wagon could, if necessary, be used for a consignment in any direction. That has been retained and, with only four owning companies, is now much simpler. The same arrangement applies to the tarpaulin sheets for covering the contents of wagons. From time to time a census is taken of the wagons and sheets to be found on each railway, so that each owning company may be credited with the number the other companies have on their lines. It was such a census that we referred to in our Seven-day Journal for December 8th.

The Railway Returns for 1932 show that during that year 271 locomotives, 837 carriages for steam-worked trains, and 6770 wagons were renewed, as compared with 380 locomotives, 1008 carriages, and 9398 wagons renewed in 1931. The list includes also 112 electric rail motor vehicles and 136 carriages for electrically operated trains; none of this class appeared in the 1931 Returns. The number of locomotives under or awaiting repair at the end of the year was 6·69 per cent. of the total stock, as compared with 6·24 per cent. in 1931. It is observed that there was a considerable increase in the number of wagons undergoing or awaiting repair at the end of 1932. The Returns also record that the hours during which locomotive power was in use decreased by 5·14 per cent. Whilst there were only small decreases in the passenger train hours and shunting hours, there was a decrease of 10·28 per cent. in the freight train hours and of 6·16 per cent. in the freight shunting hours. The passenger train miles per train hour increased from 14·72 in 1931 to 14·84 in 1932 and per engine hour from 3·61 to 3·70. Freight train miles per train hour increased from 9·11 to 9·58 and per engine hour from 3·61 to 3·70. These particular figures, we would observe, are indicative of the average speed, and it is gratifying to note that the Returns observe that the figures for 1932 are, in each case, the highest recorded since these figures became available—in 1920.

Notes and Memoranda.

According to Mr. H. J. Gower, of the Streets Committee of the City Corporation, London, the cost of rubber paving is four times that of wood or asphalt.

At the Congress of the British Institute of Radiology, Dr. A. Bouwers exhibited one of the world's smallest X-ray apparatus, weighing 7 lb., yet being capable of taking photographs in 2 sec.

According to the Dominion Bureau of Statistics at Ottawa, Canadian asbestos producers delivered 16,393 tons of asbestos in August, the highest total for any month since October, 1931. In July 14,531 tons were produced and in August last year 9918 tons. During the eight months ended August 31st deliveries totalled 79,556 tons, as compared with 72,539 tons in the corresponding period of 1932. Exports advanced from 13,490 tons in July to 17,645 tons in August.

Stainless steel has not been seriously considered in America for underground pipes except under unusual conditions because of its relatively high cost. Its behaviour in soils in which the oxygen supply is limited has not been fully determined. The U.S. Bureau of Standards is now testing a variety of iron-chromium alloys in a wide variety of soils. One test by an oil company of an alloy containing 18 per cent. chromium and 8 per cent. nickel showed favourable results in a soil containing sulphates where commercial steel and an alloy containing 5 per cent. of chromium both showed rapid corrosion.

The mechanical properties of non-ferrous metals at low temperatures were recently discussed in a paper by Mr. E. W. Colbeck and Dr. W. E. MacGillivray, read before the Institution of Chemical Engineers. From the work done in the research laboratories of I.C.I. (Alkali), Ltd., it would appear evident that the excellent properties of the copper-nickel alloys, 70–30 brass, and nickel silver throughout the temperature range from 20 deg. to −180 deg. Cent., will make them valuable materials for plant to work at temperatures below zero. These materials have been tested in the annealed state and their large reserve of ductility suggests that it would probably be safe to use many of them in a slightly harder condition.

An example of the troubles which may be caused by temperature changes is mentioned by M. H. Ball in the *Machinist*. A job required close work in machining diameters of about 48in. on brass castings. Trouble was encountered when using a steel gauge. Interchangeability could not be maintained until a brass gauge was substituted for the steel. The brass gauge was subject to the same linear expansion as the work during temperature changes, whereas the difference in the two metals when the steel gauge was used added to the troubles. The difference in the expansion of the steel gauge and the work was 0·0024in. for a temperature range of 20 deg., which was sometimes experienced in the shops.

A pipe-cutting and bevelling machine has been made by the Linde Air Products Company, New York. It consists of a centre rod with three spreading arms, which press against the inner wall of the pipe, holding it in position, with an arm supporting a blow pipe that can be adjusted to the desired angle of the cut. The blow pipe and arm rotate without the use of a crank for quick centring of the device, and by means of a crank when doing actual cutting. This machine will take almost any hand-cutting blow pipe, is readily portable, and is simple to operate. Once centred in the pipe, the operator merely turns the crank causing the blow pipe to rotate evenly around the pipe, making a clean machine-like cut.

According to an extract in the *Chemical Trade Journal*, the chemical resistance of lead can be materially enhanced by the addition of small quantities of copper, antimony, silver, &c., provided that these additives form no eutectic mixture with the lead. In other words, these metals are not to be alloyed with the lead, but to be mixed with it mechanically. They can, for instance, be in the form of shavings mechanically pressed into the lead surface, or they can be coatings formed by electro-deposition. Experiments have demonstrated that lead, over which a thin partial coating of silver has been rolled, has greatly enhanced resistance to hot concentrated sulphuric acid, whilst lead containing the same quantity of silver as an alloying material shows no improvement in acid resistance over the untreated lead.

In the discussion following the reading of his paper on "The Trends of Machine Tool Design," Mr. I. H. Wright said that the firm with which he was connected had been slide grinding for about four years. The examination of ground slides showed that slide grinding was superior to scraping for heavily loaded slides, such as the table for a milling machine. With scraping there was a considerable tendency to scratching of slides, and with slide grinding that did not so readily occur. Before seriously deciding on slide grinding, they had made tests with flat plates under equal conditions of lubrication, planed, scraped, and ground. These were reciprocated thousands of times with a very small amount of oil on them, and the ground surfaces showed very great superiority over either the scraped or planed.

Unfortunately, magnesium is very liable to corrosion, especially when exposed to sea water or moisture. An impetus to its more extended use should therefore follow from the discovery of satisfactory methods for protecting it against corrosion. Some very promising methods for this purpose have resulted from work carried out at the Chemical Research Laboratory of the Department of Scientific and Industrial Research, and were described last week by Dr. Bengough and Mr. Whitby to the Institution of Chemical Engineers. The process has the merit of simplicity, as it consists only in immersing the magnesium materials in a solution of selenious acid or its salts for about 15 min. This results in the article becoming covered with a protective coating of selenium. The value of the treatment, Dr. Bengough pointed out, is likely to be greatly increased by the fact that the coating appears to afford a very satisfactory basis for applying paints which may sometimes be necessary in cases of prolonged or severe exposure. The lecture was illustrated by figures showing the great superiority of this British process over competing foreign processes.

Miscellanea.

It is proposed to expend £22,500 on building a retaining wall in Cowes Harbour, Isle of Wight.

A demonstration plant for the manufacture of "Coalite" is to be erected at Lens, France.

The Sub Nigel gold mine, South Africa, is to put up a new reduction plant, with a capacity of 50,000 tons a month.

The Great Western Railway has ordered 100,000 steel sleepers, weighing 10,500 tons, from Guest, Keen and Nettlefold.

A seam of coal and carbonaceous shale, 77ft. thick, has been discovered at a depth of 117ft. at Driefontein, Transvaal.

A company with a capital of about £200,000 has been formed in Manchukuo for the manufacture of explosives. It will probably secure a monopoly from the Government.

An order has just been placed with Scotts Shipbuilding and Engineering Company, of Greenock, for a large passenger liner, to be equipped with oil engines by the builders.

A competition for the design of a hangar for airships is being held by the section for scientific research, Dirigeablestroy (Civil Aerofleet), Moscow, Russia. The first prize is 10,000 roubles.

There is announced the death of Henry H. Westinghouse at the age of eighty years. He was brother of George Westinghouse, the inventor of the air brake, and was himself a distinguished engineer.

An arrangement has been made between Edgar Allen and Co., of Sheffield, and the Buell Combustion Company, of London, under which the pulverised fuel plants of the latter firm will be manufactured in Sheffield.

It was stated by the Under-Secretary for Air in the Commons that the experiment recently carried out with an Air Force squadron using only petrol produced from British coal had so far given generally satisfactory results.

It is reported in the *Chemical Trade Journal* that a still further extension is to be made to its bromine plant by Palestine Potash, Ltd. Sales of crude potash salts are understood to cover production for several months ahead, two of the principal buyers of this Dead Sea potash being Canada and Australia.

The Budapest city authorities have decided to heat and light the city with the sewage which flows through the drainage system. Mr. Zaits, the city's technical adviser, states that he proposes to erect a giant closed concrete basin, in which the sewage will collect and ferment, thus creating methane gas.

An interesting experiment was recently carried out by the Industries Department of the Mysore State in the erection of a gas plant for generating electric power from lantana charcoal. The experiment yielded satisfactory results, inasmuch as it was found possible to generate electric power at a cost of about 1 anna per kWh.

The Tinnevelly–Tuticorin Electric Supply Corporation has completed the erection of the new electric installation at the Tuticorin power house, and also the laying out of transmission lines in Tuticorin, Tinnevelly, and Palamcottah. The generator and the transmission lines have, says *Indian Engineering*, been tested with satisfactory results.

Exhaustive experiments with a new process of producing petrol from sawdust and peat are being undertaken by the Swedish Government, according to Professor Komppa, the well-known Finnish chemist, who invented the process. The Swedish authorities have granted a subsidy of £8300 for the building of an experimental factory.

According to *Die Chemische Industrie*, there is to be erected at Mazanderan, in the neighbourhood of Teheran, a tar distillation plant, principally for the production of heavy oils for the impregnation of railway sleepers. A considerable quantity of the plant has already been installed, and it is expected that the works, which are near the Schemschak Coal Mines, will shortly commence operations.

Continued low water in the harbour at Montreal with its serious effect upon shipping, has resulted in urgent requests being made upon the Department of Marine for definite action to correct this situation. A proposal has been made to the Department for the creation of a series of low under-water dams along the river between Montreal and the wide section below Montreal known as Lake St. Peter; also for the construction of a dam near the outlet of Lake St. Peter to restrict the discharge of the river at that point.

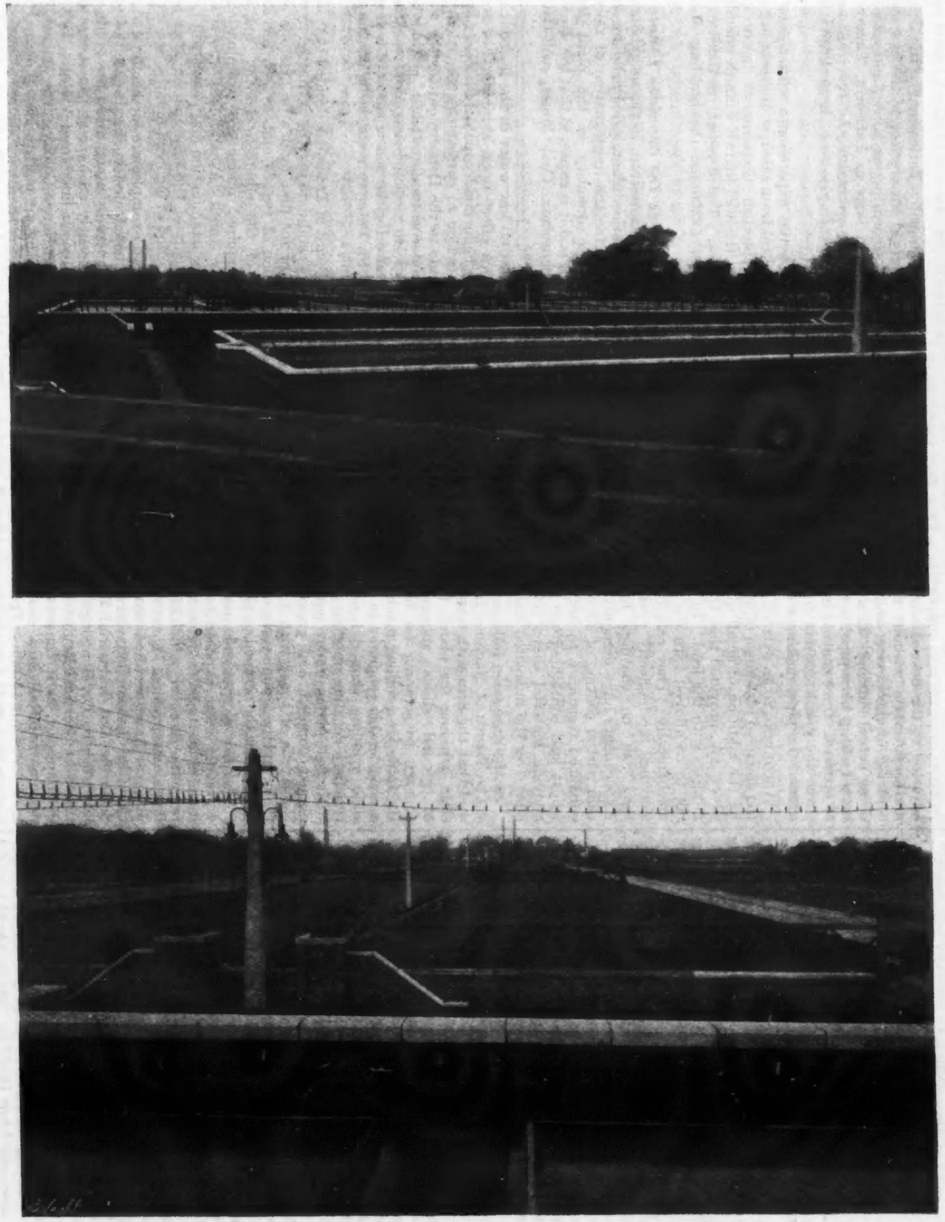
The Board of Trade has decided that in present circumstances a candidate may be permitted to sit for the written portion of his first mate's or master's certificate on the completion of twelve months' sea service (foreign-going) instead of the eighteen months' sea service (foreign-going) required under the examination regulations as they now stand. A candidate who sits for the written part of his examination and passes will be allowed to take the oral part of the examination after he has completed the full period of eighteen months' sea service.

Striking examples are forthcoming of the time savings that can be effected in the dispatch of urgent loads over long distances by a combined use of air and ocean transport. Recently an express parcel was consigned by air mail and ocean liner from Victoria, British Columbia, to Nairobi, in Kenya Colony. This packet, on its first stage, was flown by air mail to New York. Here it arrived in time to catch the liner "Europa," and after crossing the Atlantic, and when still 600 miles from Land's End, it was catapulted from the liner, with other express mail matter, and flown by seaplane to Southampton. After this the parcel was airborne by Imperial Airways from London *viâ* France, Italy, and Egypt to Africa, duly reaching Nairobi after having travelled 10,000 miles by air and sea in thirteen days. By ordinary transport the journey would have occupied more than a month.

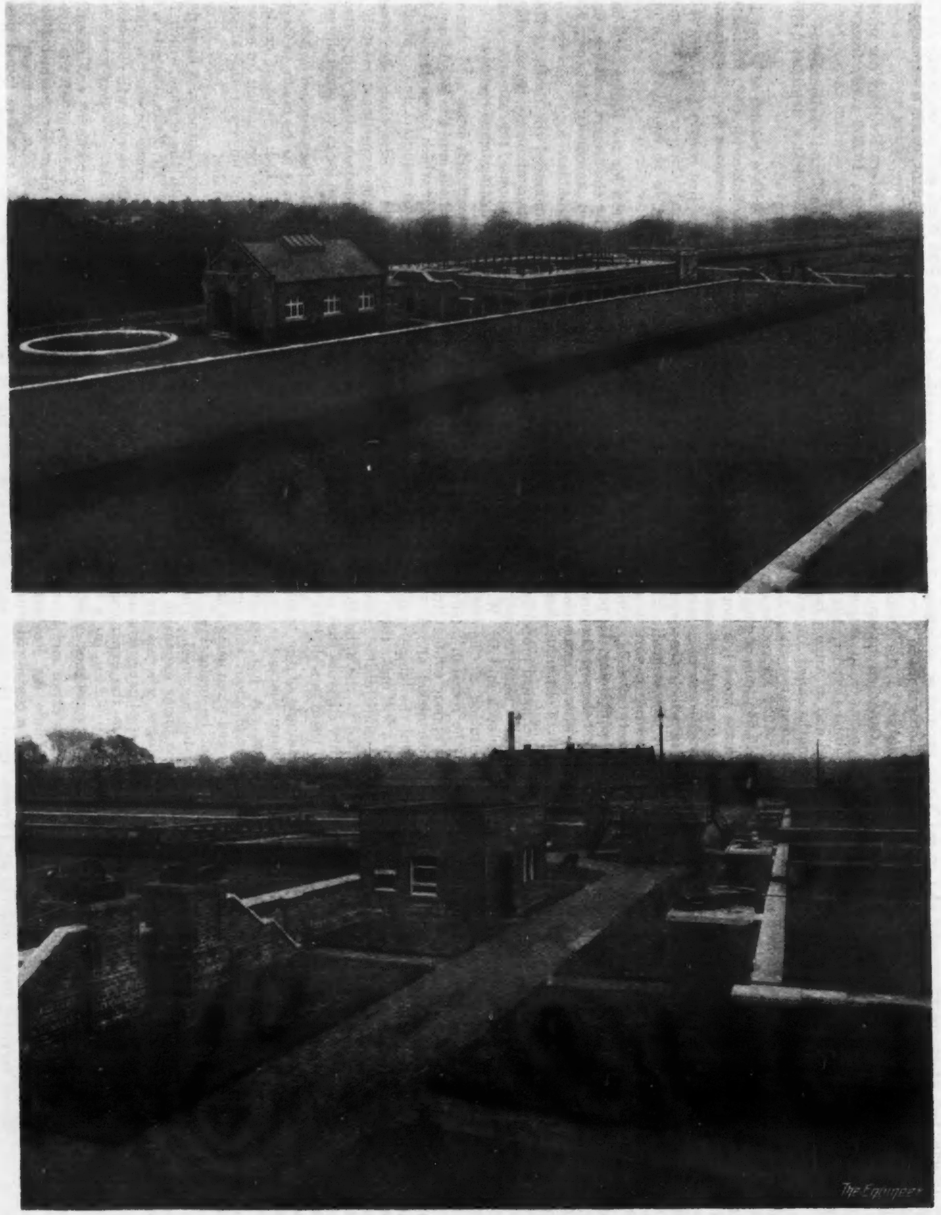
WANDLE VALLEY SEWAGE DISPOSAL WORKS

MESSRS. WILLCOX AND RAIKES, BIRMINGHAM, CIVIL ENGINEERS

(For description see page 592.)



ABOVE: GENERAL VIEW SHOWING SETTLING TANKS
BELOW: BACTERIA BEDS AND SEWAGE DISTRIBUTORS



ABOVE: PUMPING STATION AND BACTERIA BEDS
BELOW: BACTERIA BEDS AND DISTRIBUTORS

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STEEL TRADE REORGANISATION PLANS.

THE duties of the National Committee for the reorganisation of the steel trade may be classed amongst the more thankless tasks of the world. On the one side it is under the persistent pressure of a Government desiring an achievement which may be claimed as a political success, and on the other it has to compose conflicting trade interests and allay natural commercial suspicions. Set up eighteen months ago to proceed with the immediate preparation of a plan to reorganise the steel industry and to bring it to such a stage of efficiency that it could meet foreign competition in the home and export markets, it was given to understand that the continuation of the newly imposed import duties depended upon its success. In April last it presented a scheme to Sir George May's Tariff Advisory Board which provided a constitution for the steel industry of a most ingenious character. Each branch of the trade was to be governed by its own Association, and there was to be a central body—then described as a Corporation—composed of representatives of the trade Associations. This latter body was to direct the affairs of the industry. The associations of manufacturers, who, in one form or another, were also consumers, were to be bound to each other by a system of interlocking rebates, quotas, and fixed prices, designed to make it impossible for any firm to leave its Association. When the scheme was presented to the industry, it became apparent that there was little hope of securing unqualified support, and as the practicability of the plan depended upon its being accepted by the great majority of those to whom it applied, it was obvious that some of its provisions would have to be modified. The National Committee, therefore, reconsidered its scheme in the light of the criticism it had received, and has now formulated fresh proposals for the consideration of the trade. In the main, however, the original plan appears to have been retained; but readjustments have been made in the representation of certain branches of the industry in order to relieve fears that their interests would be swamped in those of the pig iron and steel-producing industries.

The National Committee is both helped and hindered by the diversity of the interests which it has had to consider, and by the close association these interests have with the steel-producing section of the trade, which, of course, is the rock upon which all the subsidiary industries are built. It is difficult to visualise a central directing organisation that could guard the interests of the steel makers and guide with equal skill and experience the fortunes of such diverse trades as the Welsh tin-plate, the Midland re-rolling, and the engineering industries. At the same time, no reorganisation could be complete were any of these industries excluded. Again, experience has shown that the problem of arranging quotas is beset by difficulties which, in the past, have shipwrecked many promising cartels. Subject to the drastic trade action possible under the Association and rebate proposals, the Committee has relied upon the voluntary principle, and even admits the difficulty of framing regulations which cannot be circumvented by keen commercial minds. This is a wise attitude, since it is certain that only a small proportion of the industry would support an attempt to dragoon by legal force the iron and steel and subsidiary trades into a scheme which its strongest supporters must admit is bureaucratic in inception and construction. Nevertheless, whilst those associated with the scheme avoid talking of compulsion, there must be at the back of their minds the knowledge that if a large majority of the iron and steel trades accept the scheme, it will be possible to obtain powers from the Government to compel the adhesion of the remainder. Obviously, this would be a situation in which neither the Committee nor the Government would care to be placed, as action of this nature might have political repercussions which it would be difficult to estimate. On the other hand, it is highly improbable that a unanimous and cordial welcome will be accorded to any scheme of such a far-reaching nature, since it is not a characteristic of the British industrialist gaily to march along uncharted paths towards a goal which cannot be easily discerned. The Government, of course, has in its hands a powerful weapon in the import duties, and many spokesmen have not hesitated to hint at its use if the steel trade does not, to use a favourite but obscure term, "put its house in order." The removal of the import duties strikes us as being remote in the extreme, and their reduction almost as unlikely. It cannot be denied that the steel industry has taken advantage of the shelter afforded by the protective duties to proceed with reorganisation plans, which, if not so wide-sweeping as the Committee's revolutionary proposals, have an appearance of sound commonsense. Not since the war have our iron and steel concerns been so busy, or have their prospects looked brighter. The Government would naturally prefer to see a larger proportion of export orders in current business, and the National Committee's plans for dealing with the export trade are amongst the most interesting of their proposals. The Committee has taken the view which is frequently urged by economists that if the steel export trade were transacted through one organisation, it would be easier to conduct important business and to maintain prices. There is in existence already the British Steel Export Association, formed a few years ago to handle the steel makers' export business in sections and plates in quantities of 250 tons and over, and it is probable that this organisation will be converted into a company to handle the overseas business of other branches of the trade. It seems likely, however, that the extent of the support it will receive may prove disappointing. The South Wales tin-plate trade, for instance, has its own organisation, the sheet makers have theirs, and few of the re-rollers would care to surrender their own selling methods. In fact, the principle of central selling is not so highly thought of amongst industrialists as it was a few years ago, and it is generally agreed that to be successful such an organisation must be supported by practically the whole of the industry for which it sells, and that the industry itself must be under rigid control. It may be thought that these requirements are satisfied by the scheme; but association in central selling is to be voluntary, and apparently the new organisation will buy and sell as a merchant concern. A proposal that export business should be assisted by an export levy may cause some concern. It is proposed that the levy should be made upon the manufacturers' home business, and be used to cheapen export prices when necessary to meet foreign competition. This at once raises the controversial question of how far it is legitimate to raise home prices to subsidise export business, a question upon which the steel trade itself is by no means agreed.

It will be seen that although the National Committee has with great courage and trouble worked out a scheme of reorganisation, it will be some time before the industries concerned can put it into effective operation, even if it is adopted by the majority of the trade. As we have pointed out, the steel trades have not been idle whilst the Committee has been at work, and although the industries may not have "regimented" themselves according to the preconceived official ideas, greater progress has been made by individual initiative behind the tariff wall than could have been expected in so short a time. It is probably within the mark to say that production has increased from about 45 per cent. of capacity before the import duties were imposed to 70 per cent. to-day. Of even greater importance are the big schemes of expansion and new development which have been undertaken, to mention only Stewarts and Lloyds' Corby enterprise, and Guest Keen's Cardiff plans. The Government has also done its share by spurring on the Committee, and the time has now come when the industry and its Committee should be left in peace to deal with their problems and their reorganisation plan. Considering the long years of indifference with which successive Governments treated the industry, a reasonable time should be allowed for it to effect a reorganisation almost revolutionary in character, as the participants will be bound for a period of ten years.

Invention and Design.

THE story of mechanical progress is mainly a record of the successes of two kinds of men, inventors and designers. The distinction may at times be invidious, for design at its highest treads on the borderland of invention, whereas invention, if it may be judged by the standards of the Patent Office, often requires no more ingenuity than may reasonably be expected of the average draughtsman. There is, nevertheless, an essential difference. What the inventor does is to create something new, which, however imperfect it may be at first, opens up some unsuspected avenue of advance, while the designer strives to attain perfection along lines already laid down. The same type of mind is at work in both cases, but how it works and why it is given to one man to conceive an idea that has eluded thousands of other workers in the same field is, and is likely to remain, a mystery. An idea is, however, but the first step towards an invention. Until it has been translated into some workable device or process it is but the airy fabric of a vision, and of about as much practical use. The inventor is far more than a man who can see visions or dream dreams in an armchair. He must have the art of making his dreams come true, and the courage, devotion and persistence he has to display before natural difficulties can be conquered and the opposition of ignorance or vested interests overcome, are at least as essential to his success as is his fecundity of mind.

It was this aspect of invention which was given prominence in Mr. C. D. Gibb's address as Chairman of the North-Eastern Branch of the Institution of Mechanical Engineers on Wednesday, December 6th. Speaking from personal knowledge, Mr. Gibb sketched some of the manifold problems which Sir Charles Parsons had to solve before the steam turbine was established on land and sea, and he threw an interesting light on the mentality of the great inventor. In the first place, Parsons had the faculty of thinking clearly. He visualised exactly what he wanted to make or to do, and then set about it in a simple and direct manner. Moreover, "while he never allowed himself to be discouraged by adverse fortune, however disheartening, and never admitted defeat, he had the instinct to know when he was 'facing a brick wall' and always planned to get round it or underneath it instead of making a futile frontal attack." Of his persistence in the face of difficulties it is recalled that he spent £25,000 on experiments with high-speed propellers before the "Turbinia" was a success. But another fact not generally known is that, even after the astonishing performance of this vessel, the Admiralty refused to consider the introduction of steam turbines into the Navy unless Parsons would first put up £100,000 for the construction of a turbine-driven destroyer, which sum was not to be refunded until after the boat had successfully passed through her acceptance tests. It was well for the country that Parsons' confidence in his invention was shared by a wealthy and public-spirited man like the late C. J. Leyland, who came forward and took the risk that the Admiralty was unwilling to face. The vessel in question was the ill-fated "Viper," which achieved the unprecedented speed of 37 knots and justified in every way the new method of propulsion before her untimely end in 1901 on the rocks of the Channel Islands. The development of the 36,000-

volt alternator might also have been mentioned by Mr. Gibb as another instance of persistent and costly experimental work culminating in the expense of building an experimental machine which could be offered with confidence as embodying the complete solution of a difficult problem on a commercial scale. These few instances give some idea of the time, labour, and money which have to be spent in order to bring an important invention to commercial fruition under modern conditions. They also suggest the exceptional type of character that alone can supply the driving force essential to the achievement. Parsons was a prolific inventor because he was gifted with a constructive genius, but he was that rarer thing, an eminently successful one, primarily by reason of the characteristics which Mr. Gibb portrayed.

In considering the history of mechanical engineering, it is surprising to notice how insignificant a part in the production of the most useful inventions can be attributed to mathematical or other academic knowledge. One would not, of course, expect mathematics to be relevant to the invention of such things as the sewing machine, the harvester, the printing press, or of any of the complicated spinning, weaving, bootmaking or other machinery, on the existence of which our material civilisatino so largely depends. But it must also be remembered that steam engines, both stationary and locomotive, were in common use before there was any science of thermodynamics, and when heat was still believed to be an indestructible substance called "caloric" that resided in the pores of bodies. We do not point out these facts with any intention of belittling the value of scientific knowledge. We wish merely to emphasise the truth that a scientific training, as commonly understood, has little more to do with invention than to prevent time and money being wasted on attempts to circumvent the Second Law of Thermodynamics, or to discourage even cruder schemes for obtaining perpetual motion. It will be found to be an almost universal rule that the scientific knowledge bearing on an invention is developed more as a consequence of the invention than as an antecedent to it. The invention comes first in point of time and the mathematics follows after. The only exception to this rule that Mr. Gibb confessed he could think of was the invention of the pivoted-pad thrust block by Michell as the direct outcome of mathematical theory. In the general case the mathematician cannot do much to guide engineers until he has some actual machine or structure to theorise about, and this presupposes its prior invention. Carnot founded the science of thermodynamics by reflecting upon the properties of the steam engine, and not *vice versâ*. Sir Charles Parsons had exceptional mathematical knowledge, having been eleventh wrangler at Cambridge, but he relied rather on intuition, checked by simple arithmetic and practical experiments when developing the steam turbine. The mathematical work which has since been done by others in connection with the thermodynamic and mechanical aspects of the turbine fills innumerable volumes, but the important point is that the turbine existed as an actual machine long before the mathematical theories were elaborated. The function of the latter is to interpret the results and to enable general rules for design to be formulated. Once this state of affairs has been reached in connection with any invention, there comes the turn of some new inventor, who, being bound by no rules but the laws of Nature, strikes out in some new direction; and so the cycle of progress recommences.

Literature.

The Development of Physical Thought. By Leonard B. Loeb and Arthur S. Adams. New York: John Wiley and Sons, Inc. London: Chapman and Hall, Ltd. Price 23s.

It must have occurred to many at some time or another that the finest system of education that could be desired, were there sufficient time for the scheme to be carried out on the youth of each generation, would be one in which the subject was treated in historical sequence. In this way the knowledge of the individual pupil would be made to grow gradually along the same path that had been traced out by the evolution of the thinking processes of the human race. The difficulties with which each pupil would have to contend would then be just those with which the great scientists years ago were wrestling, and each step would follow in orderly sequence from the last. Unfortunately, only an approximation to such a system of education can be adopted owing to the exigencies of time, and the student must by giant strides skip the human, easily understood, errors of earlier generations and be taught at once the scientific facts and theories of the present day. But if on the large scale any such system of education is impracticable we are not prevented in later life from adopting it upon a smaller, less detailed scale with pleasurable, if not necessarily valuable, results.

These reflections were engendered by the enjoyment with which the reviewer read "The Development of Physical Thought," by Leonard B. Loeb and Arthur S. Adams, for in this work the historical method of presentation has been adopted as far as possible, and is thereby demonstrated to be particularly suited to a scientific subject. The number of books published in recent years, and dealing in particular with the modern scientific conception of the universe, bears witness to the widespread interest that is felt in the latest developments. But many of those who have read this more or less popular literature with enjoyment and profit must have felt a desire to penetrate further and to gain a greater insight into the why and wherefore of the various theories. Probably, however, they have been deterred from attempting the more advanced works by a realisation of their own mathematical failings and an uncertainty of the quality of their scientific grounding. What is required is something that is neither "popular" nor "technical," but in this field there has been a distinct gap in scientific literature of recent years. We have no "Huxley" and no "Tyndall" to explain to us in simple language the most advanced principles of the scientists without descending to the purely popular level. The authors of the present work would claim no equality of merit with these famous writers of the last century; nor can it be claimed for them. But at least in a different style, and with less genius for expression, they have produced a book that goes far to fill the literary gap at present existing. Some of the qualities of great writing, too, can be observed in their work. The best lecturers and authors have the quality of imbuing in their students a confidence that, however complex the subject, it is well within their intellectual powers to comprehend it. In reading the present work, one is conscious to some extent of just that confidence, though it is perhaps due to the historical method of treatment and to a certain clarity of description rather than to any genius for choosing the right simile or the simplest analogy. Nevertheless, credit attaches to the authors for choosing a manner of approach which could successfully pass between the Scylla of a collection of pretty qualitative facts and the Charybdis of a mass of formulæ and equations, and which could, without the use of more mathematics than is included in a school course of algebra and geometry, yet give the reader a sound conception of the present position of physical thought.

Naturally enough, in view of its method of construction, the book falls into several parts. For though all sciences may now be regarded as parts of a single "whole," historically they were developed in more or less water-tight compartments. Thus beginning with a part dealing with early history before the scientific experimental methods of the last few centuries were developed, the authors break up their history into its branches, mechanics, heat and the structure of matter, electricity and magnetism, and light in the succeeding pages bringing them together again under the heading "The Electrical Structure of Matter and the New Physics" for the final part. The result is a volume that may be read, not, perhaps, with the ease one associates with a novel, but at least without that mental indigestion which is stimulated by a heavily learned presentation. Almost effortlessly those "tag-ends," the points which, somehow during one's period of training at college or university eluded one's intellectual grasp, are picked up and made clear, and the way is smoothed for the approach to more difficult conceptions. If, in the later pages, matters are not described so clearly, that is not entirely the fault of the authors. Many of the modern conceptions are vague when expressed in any way other than that of mathematics, while others are matters for dispute or discussion among the scientists themselves. In such circumstances only a touch of genius denied to the majority of mortal men can avoid instilling a certain degree of confusion into the mind of the student.

As in many books nowadays, the old system of footnotes giving references to authorities has been dropped in the production of this volume, and the authors have adopted the plan of collecting references to the works of many authors dealing with the conceptions of higher physics on the last few pages before the index. Particularly in such books as this, where references in the text would tend to interrupt the easy flow of the author's discourse, the system adopted is to be recommended.

Practical Acoustics for the Constructor. By C. W. Glover, A.M. Inst. C.E., M.I. Struct. E. London: Chapman and Hall, Ltd. 1933. Price 25s. net.

Although several books of fairly recent origin on the theory and application of acoustics are available, none are so definitely adapted as this new publication to the requirements of the student and practical man interested in the subject of architectural and constructional acoustics. The primary purpose of this treatise, according to the preface, is to set down in a concise form the general principles underlying the applications of acoustical engineering as logically developed from fundamental assumptions. The basis of treatment is largely experimental, and the text is arranged so that it provides a suitable foundation for a progressive course of lectures, and also as an aid for teaching purposes. The subject is discussed in its widest aspects, including the general principles of wave motion, reflection, interference, transmission, and absorption of sound, the acoustical design of buildings, insulation and vibration. The aim throughout has been to treat comprehensively the fundamental principles, so that with thorough assimilation their application to particular problems may present no difficulty.

In certain cases what appear to be original, or little-known methods of attacking the problems, are introduced with advantage. There is an interesting chapter on the effects of reverberation, in which the optima for broadcasting, sound film studios, and gramophone audition rooms is discussed and guidance given for the adjustment of acoustical conditions. Some recorded results are of considerable practical importance, since it is not possible, except by the use of adjustable absorbents, to provide acoustical conditions which will be conveniently satisfactory for the manifold uses to which an auditorium may be put. The section on methods applied for investigating the reflecting characteristics of interiors, deals in an authoritative manner with the photography of sound pulses in a model and the use of the Echo Locator in the building itself.

The author considers that a typical example of faulty acoustical design is that of the Albert Hall, London, being elliptical in plan, with a domical roof, voluminous and reverberant. The correct control of the acoustics of music rooms is very clearly discussed, and its applications to various common arrangements shown. Some typical specification clauses for alternative materials are given as a general guide for the student, but in some cases modifications may be necessary in order to satisfy particular requirements or conditions. The illustrated particulars of numerous acoustical materials, a detailed bibliography, and a summary of acoustical defects are features of the volume which are of outstanding value.

The subject of human susceptibility to noise has received much prominence within recent years, and methods of arriving at remedial measures likely to be most effective in the prevention of vibration and sound transmission are discussed. These include those resulting from ventilating systems, heating installations, water services and lifts. A summary of acoustical coefficients and illustrated particulars of acoustical materials is given in an appendix, and there are numerous uniformly excellent diagrams which, in just a few cases, are not conveniently situated in relation to the corresponding text.

The text gives some indication of the amount of work which has been going on in the sphere of acoustics during the last few years, and one is impressed still more with the amount of patient labour which must have been expended in order to bring the science even to its present position. It must be acknowledged that the development of acoustical science has resulted from, and will rest on, the extension of theoretical work. The reasons why this branch of scientific thought has only comparatively recently been studied with any degree of precision are, first, because of the lack of a theoretical basis, and secondly, because of the experimental difficulties which have had to be overcome. The author does not appear to be at his ease when discussing problems associated with aircraft noise abatement, and the chapter dealing with this subject might with advantage be re-written in the event of a subsequent edition appearing. We would also suggest that statements such as "it would be necessary to have a man speaking continuously day and night for 170 years to generate enough acoustical energy which, when converted into heat, would be sufficient to make one cup of tea" (p. 104) might be left to the popular weekly, and not incorporated in a scientific treatise. The humourous (?) drawings, *e.g.*, p. 61, are not becoming in an otherwise well-prepared volume.

In spite of these observations, which are intended to be constructive rather than critical, it is evident that a great deal of thought and energy have gone towards the completion of a difficult task. Not the least useful feature of the treatise is the inclusion of a number of beautifully reproduced natural-size photographs. Moreover, in order to provide familiarity with the types of problems likely to be encountered, there appears at the end of each chapter a number of exercises for the guidance of the student, and for those who wish to widen their knowledge of the subject.

Road Engineering. By E. L. LEEMING, M.Sc., Assoc. M. Inst. C.E., M. Inst. M. and Cy. E. London: Constable and Co., Ltd. Second edition. 1933. Price 18s.

IN the preface to the first edition of this book, it was described as an attempt to give in a concise form the technology of road construction in the light of the new conditions created by modern traffic. In his preface to the new edition the author further explains that no single volume being adequate to cover the wide field of road engineering, his book is intended to give the general engineering requirements and principles, with the design, plant, and execution of modern works of road construction. Largely in respect of principles, and in regard to many aspects of design, the book fails to satisfy expectations based upon those descriptions of its character.

The work of revising and supplementing the original matter has been well done. Clear explanations are given of methods now generally followed, but seldom, if ever, applied until quite recently. In the chapter on curves, the importance of the transition curve, so long neglected, is made evident, and explanations are given of the employment of the spiral, the parabolic, and Bernouilli's lemniscate curves. The subject of superelevation at bends is handled with good judgment and considerable skill; but the author might have added to his own clear presentment the information that there is a strong body of opinion against a steeper slope than 1 in 12, and that a range of 1 in 12 to 1 in 15 has successfully been adopted by a number of highway engineers.

The author has the courage of his opinions in respect of the slipperiness of asphalt carpets of that class and character the qualities of which were not sufficiently studied before their adoption on a large scale. Discussing the causes of skidding he observes that "the onus would appear to lie with the road engineer rather than with the vehicle designer, as the condition of the road surface in wet weather is primarily responsible for a skid." The first in his list of ten causes of skidding is "smooth, fine road surfaces of bituminous asphalte, having a low coefficient of friction when wet." He remarks, very diplomatically, but unequivocally, that "a considerable mileage of roads with this material has now been constructed in this country, and some treatment is necessary to increase the frictional resistance to wheel traffic. Many of these roads have been laid down at considerable cost and without any thought of annual surface treatment."

References to recent developments in the provision of traffic signals and in measures of traffic control include discussions of the latest systems of controlled and automatic signals.

It is unfortunate that the author, who is a highway engineer of proved ability, and whose judgment, as this book shows, is sound in regard to many aspects of highway engineering, should fail to provide safe guidance in respect of some of the essential principles, basic facts, and important features of design. Apparent in regard to structural features of the roadbed and the carriageway, this failure is most conspicuous in the chapter on subsoils, drainage, and earthworks, which contains only nineteen pages, ten of which are devoted to the qualities of soils. The observations made in the nineteen lines on "curative treatment of subgrades," is definitely misleading as an outline, even, of the main factors to be taken into account in the preparation of the roadbed. The purport of the observations relating to methods of effecting subsoil drainage is, in so far as it can be grasped, unconvincing. The matter under the headings "natural drainage," and "earthworks" occupies only seventy-two lines, the treatment conveying wrong ideas as to the character and importance of the problems and the provisions that should be made to meet various conditions. Mr. Leeming falls into line with those highway engineers who ignore the experience of thousands of years in the control of earth and water, regarding those substances with deep mistrust, and, on the slenderest of pretexts, resorting to the reinforced concrete carriageway.

Since, however, most of the chapters are well written, the subjects adequately discussed, and sound advice given as to methods of construction, it is to be concluded that the book is likely to continue to provide useful guidance for students, while it is a handy work of reference for highway engineers.

Die Statik im Eisenbetonbau. Vol. I. By KURT BEYER. Verlag von Julius Springer, Berlin, W.9, Linkstrasse 23-24. Second edition. 1933. Price R.M. 32·50.

THE title of this work, "The Statics of Reinforced Concrete Construction," seems to have been chosen in order that it might be understood that the author does not attempt to cover the subject as relating, in its closer applications, to structures of other materials. Probably, also, in the second volume —in which there will be a fuller presentment and solution of problems relating to constructions such as continuous beams and girders on elastic supports, continuous frames and other of the more complicated dispositions—the examples will be mainly reinforced concrete structures. As regards the volume under review, the special consideration given, here and there, to reinforced concrete, does not affect its character as indicated in the sub-title (of the whole work) of "A Text-book and Handbook of Structural Statics." Comparable as regards print, illustrations, paper, and binding, with books published by leading English houses, the volume can largely be understood by an engineer conversant with the subject, though his knowledge of the German language be but slight. Employing international symbols and methods, Dr. Ing. Beyer, who is a Professor at the Technical High School, Dresden, makes use of diagrams and tables of familiar forms, largely employing, in tables of functions, constants, and other numerical values, a column of small diagrams indicating the structural form relating to each line of figures. For beams alone eight pages of such matter and a large folding plate are furnished.

The large pages, 9½in. by 6¼in., allow of very clear presentment of tabular matter and graphs, and though the reference numbers, each relating to a line, or a series of lines, of mathematical expression, total more than 630 and the figures number about 350, the book is well supplied with studies of the groundwork of the subject and with explanations and discussions of problems and of the methods of their solution. The author's treatment and solutions of retaining wall problems are on familiar lines, but in a table on page 12 of five functions for massive retaining walls, these are given for eleven kinds of earth or ground material, and, in respect of six of those materials, the value of "gamma" is given for the conditions—dry, naturally moist, and saturated. In an exposition of the solution of the statics of a silo, results are given, separately for wheat and rye, for internal, or load, heights up to 21 m., while another table (page 14) gives the four physical constants for six mineral or similar materials, including coal and cement, for five cereals, and for beans, peas, linseed, malt, and salt.

Influence lines are discussed, the method of explaining strain problems with the aid of distorted figures is usefully employed, and considerable attention is given to the solution of problems such as are presented by frame structures having north-light or other unsymmetrical roofs, to take only a few examples which may serve to suggest the thoroughness of the treatment of the subject.

Dr. Kurt Beyer's lucid exposition may be regarded as usefully supplementing the information contained in British and American works on structural statics.

SHORT NOTICES.

Automotive Engines. By P. M. Heldt. Nyack, N.Y. P. M. Heldt. 1933. Iliffe and Sons, Ltd., London, agents. Price 32s. 6d.—This edition is the eighth through which this book has passed, a sufficient tribute to the fact that automotive engineers have found it of value. Much new material has been added and alterations have been found necessary in chapters devoted to particular parts. A complete new chapter on Torsional Vibration and Vibration Dampers has been added and presents a comparatively simple method for predetermining the critical speeds of torsional vibration. In addition, the chapter on the Determination of Bearing Loads has been completely re-written. Some idea of the amount of revision rendered necessary by the continued rapid advance in engine design may be gained from the fact that more than 100 new illustrations are included in the present volume. In order to make it possible to issue the book at a price lower than that of the previous edition, the decision was made slightly to narrow its scope. Consequently, the chapters on Diesel-type Automotive Engines, Two-stroke Cycle Engines, and Sleeve-valve Engines, have been left out. As to the omission of the first, there can be little doubt that it was a wise move, since the development of this form of engine has now reached the stage where its discussion can fill a whole volume. As to the others, the importance of these types appears to be on the wane, and if anything had to be left out it was better that it should be these chapters than that the very full treatment of the rest should suffer curtailment. The book is, of course, an American one, and deals most particularly with American practice. Nevertheless, the general theoretical and fundamental principles of automobile engine design are necessarily the same on each side of the Atlantic, while the practice is not so far different that that of the one country can learn nothing from that of the other.

Technique of Modern Welding. By Professor P. Bardtke. Translated from the second edition by Harold Kennedy. London: Blackie and Son, Ltd. 1933. Price 15s.—This book was first published in Germany four years ago, but since that date development in welding practice and in the knowledge of the processes involved has been so rapid that it was necessary to make a very thorough revision. Consequently, even in Germany the book may be regarded as practically a new one, while in our English translation it is quite new to this country. Indeed, as the translator has revised certain sections of the German second edition, and brought them into line with the most recent developments, it might almost be said that the English translation is of greater value than the original German. The book is divided into three parts—Welding Processes; Applications and Tests of Welded Joints; and Gas Cutting. In the first part, after an introductory chapter on the history of the subject and the definitions of the various technical terms, fusion welding, pressure welding, and aluminium thermit welding are discussed. The equipment necessary, its installation, the preparation of the material, and the actual process as applied to various metals are described. In the second section the application of welding technology to various jobs is described, and a discussion of the stresses welded joints may be expected to stand and methods of carrying out tests is presented. A chapter on accident prevention also finds a place in this section. Part III. —Gas Cutting—as might be expected, is the shortest, occupying only 18 pages out of a total of 299.

Modern English Punctuation. By Reginald Skelton. London: Isaac Pitman and Sons, Ltd. 1933. Price 2s. 6d.—Why anyone should want a manual on Punctuation, and how "modern" punctuation can differ from ancient punctuation, we find it hard to understand. Possibly it arises from the ever-increasing desire to do everything according to rule and to remove all trace of those little inconsistences which add a spice to literature. There is but one sound rule for punctuation, and none other matters. Use the stops so that you may increase the clarity of your expressions, and do not use them to excess. We are glad to observe that Mr. Skelton displays a good deal of common sense in making his recommendations, and with some of them which are opposed to common practice we are in full agreement. With others we do not agree. As we say, we find it hard to understand why people get confused over punctuation, but as there are such people, this book may serve a useful purpose, if it does not blind writers to the simple rule which we have enunciated. If everyone was taught, as young people used to be taught, to read aloud, punctuation would lose its terrors.

The Mechanical Transmission of Power. By the late G. F. Charnock. London: Crosby Lockwood, Ltd. 1933. Price 8s. 6d.—This little book of 148 pages is particularly concerned with the transmission of power to line shafting, but since the general principles are the same in any form of mechanical transmission, this limitation is not in the least disadvantageous. In the introductory chapter, the importance of making allowance in the design of a factory building for the forces brought into play by line shafting is stressed, and the various methods of power transmission are classified. The remaining chapters, all of which are profusely illustrated, principally by scale drawings, are concerned with Bearings for Line Shafting; Belt Driving; Types of Pulleys; Rope Driving; Chain Driving; Toothed Gearing, including Some Description of Methods of Producing Gears; Friction Clutches for Power Transmission; and, finally, Variable-speed Transmissions. Although not unduly obtruded, the mathematical side is not neglected. Much use is made of graphs and other similar explanatory diagrams.

Automobile Electrical Equipment. By A. P. Young and L. Griffiths. London: Iliffe and Sons, Ltd. 1933. Price 15s.—In this book a subject of great importance to the automobile industry and to the aircraft engine designer is studied. Ever since motor cars were first produced the use of electricity, not only for ignition purposes, but also for the operation of auxiliaries, such as the lights, horn, and windscreen wiper, speedometer, petrol gauge, &c., has been increasing. So much, in fact, is this the case that the authors have found plenty of material to fill a book of 330 pages. As might, indeed, be expected from its relative importance, the subject of ignition takes up a very large proportion of the book, which, besides describing various types of magnetos, sparking plugs, coils, distributors, &c., also discusses the principles underlying the design of such components. Other important sections are concerned with batteries, the starting motor, and the dynamo or generator. The subject of lighting is not neglected, and the dazzle problem is discussed and several anti-dazzle devices described.

The Elements of Reinforced Concrete Design. By H. C. Adams. London: Concrete Publications, Ltd., 20, Dartmouth-street, S.W.1. Price 6s. net.—This textbook is intended to be a complete course for the student of reinforced concrete design. It contains a full discussion of the statics of structures and shows by worked examples how any concrete structure is supported. Examples are given of designs for simply supported and continuous slabs and beams, columns and footings, thus providing all the necessary details for designing a structure. The author explains the action of earth pressure on retaining walls and gives complete designs of cantilever and counterpart walls. The book is written in simple language and uses only the most elementary mathematics, and the information it contains is based upon the practice of British firms specialising in reinforced concrete construction.

Radio Upkeep and Repairs for Amateurs: A Practical Handbook in Fault-clearing and Set Maintenance. By Alfred T. Witts, A.M.I.E.E. London: Sir Isaac Pitman and Sons, Ltd. 1933. Price 5s.—Of the millions of users of wireless there is certainly a very large number who like "fooling about with the radio," as Stevenson liked "fooling about with boats." To them, if they are not already adepts, this little book will be a godsend, and if they are adepts they will enjoy it, for we all like reading about our hobbies. It is an excellent guide to fault-finding, but its title hardly does it full justice, for it carries the reader beyond maintenance into actual improvements and additions. We commend it as a suitable Christmas gift for the embryo radio-fan.

Standard Methods of Analysis. Sheffield: The United Steel Companies, Ltd., 17, Westbourne-road. Price 4s. 6d. net.—This little volume is the product of a committee of chemists and metallurgists from the various laboratories of the United Steel Companies' works. It contains the selected standard methods of analysis of iron, steel, and ferro-alloys now employed in the manufacture of the companies' output, and no short or approximate methods are given. There is no doubt that this book will be read with much interest by all connected with the iron and steel industry.

A.C. Voltage Regulators.

No. IV.

(*Continued from page 566, December 8th.*)

ALTHOUGH the Cowan-Still induction regulator made in modern form by Switchgear and Cowans, Ltd., of Old Trafford, Manchester, was invented as far back as 1895–6, other types of regulators of more recent origin have by no means rendered it obsolete. Well known as the principle of operation is, it is, perhaps, advisable to explain that the variation of mutual inductance between two sets of windings, brought about by a change of position of one with respect to the other, gives the pressure regulation desired. The primary or shunt winding A, Fig. 33, is connected across the supply circuit, the secondary B being in series with the circuit to be controlled. Usually, the primary is mounted on the movable core, while the secondary is stationary. Voltage variation is obtained by altering the angular position of the former relative to the latter. The alternating magnetic flux produced by the winding A induces a pressure in the secondary B, which varies in magnitude with the angular position of the rotor.

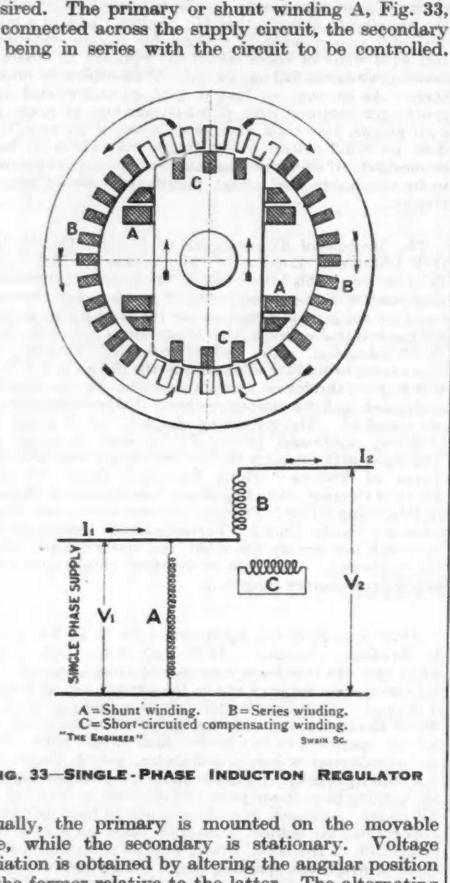

C
A
B
B
A
C
I_2
B
I_1
C
V_1
A
V_2
SINGLE PHASE SUPPLY
A = Shunt winding. B = Series winding.
C = Short-circuited compensating winding.
"The Engineer"
Swain Sc.

Fig. 33—Single-Phase Induction Regulator

In a single-phase regulator, such as that shown in Fig. 33, voltage variation from full boost to full buck is effected by turning the rotor through 180 deg., which can be done when necessary on an automatic motor-operated Switchgear and Cowans regulator in a period of seven seconds, or even less, with the use of a special relay. The electromotive forces produced in the stator by this rotary motion are, of course, quite negligible in magnitude as compared with the maximum electromotive force due to flux alternation. The object of the short-circuited compensating winding C is to limit the leakage reactance of the stator winding, which would otherwise reach a prohibitive value as the rotor approached the mid or neutral position. It is claimed that in the latest single-phase regulators made by Switchgear and Cowans, an unequalled uniformity of leakage reactance is attained without the introduction of large magnetising currents, a matter of particular importance in the case of a low power factor. As the rotor and stator slots are proportioned so that the air gap reluctance is uniform throughout the range, it follows that the magnetising current is also uniform and that the rotor is not subjected to a uni-directional torque pulsating at twice the frequency of the supply and consequent vibration.

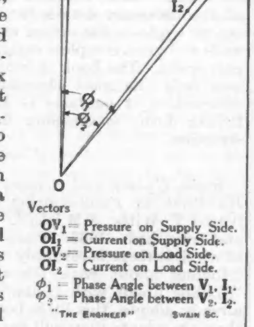

E_2
V_2
V_1
I_1
I_2
ϕ_1
ϕ_2
O
Vectors
OV_1 = Pressure on Supply Side.
OI_1 = Current on Supply Side.
OV_2 = Pressure on Load Side.
OI_2 = Current on Load Side.
ϕ_1 = Phase Angle between V_1, I_1.
ϕ_2 = Phase Angle between V_2, I_2.
"The Engineer"
Swain Sc.

Fig. 34—Single-Phase Gulator Vector Diagram

The approximate relations existing between the pressures and currents on the supply and load sides of a single-phase regulator capable of giving 20 per cent. boost and an equal buck, are shown vectorially in Fig. 34. The regulator is assumed to be in the full boost position, with the line fully loaded and with a lagging power factor of cos φ_2 on the load side. At full load the internal reactance drop is taken as approximately 20 per cent. of the voltage boost, or 4 per cent. of the supply voltage O V_1. Similarly, the magnetising current is assumed to be 20 per cent. of the shunt winding full ratio current, *i.e.*, 4 per cent. of the full load current O I_2. As the vector diagram shows, the effect of these internal characteristics on the power factor of the line is small, particularly as the boost and buck required are most frequently 10 per cent. and less. Under full load conditions, the maximum difference between φ_1 and φ_2 at unity power factor in the case of a regulator for 10 per cent. boost and buck with a 20 per cent. magnetising current, and 20 per cent. internal reactance, approximates 2·3 deg.

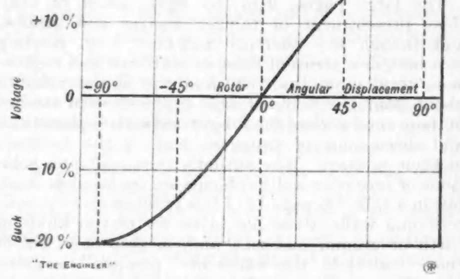


Fig. 35—Induction Regulator Characteristic Curve

From the operating point of view, the relationship between the booster voltage induced in the series winding and the rotor position is important, for the sensitivity with given control gear depends on the nature of this relationship. A characteristic curve is given in Fig. 35 of voltage boost plotted against rotor angular displacement for a Switchgear and Cowans single-phase induction regulator working under no load conditions, while Fig. 36 shows the leakage impedance plotted against rotor angular displacement and indicates the satisfactory form of the voltage boost angular displacement curve for any loading condition. It also shows the variation in copper loss with full load current in the series winding for the entire range, and it will be observed that the copper losses are lowest in the neutral position.

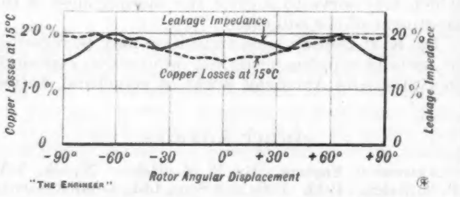


Fig. 36—Leakage Impedance and Copper Loss Curves

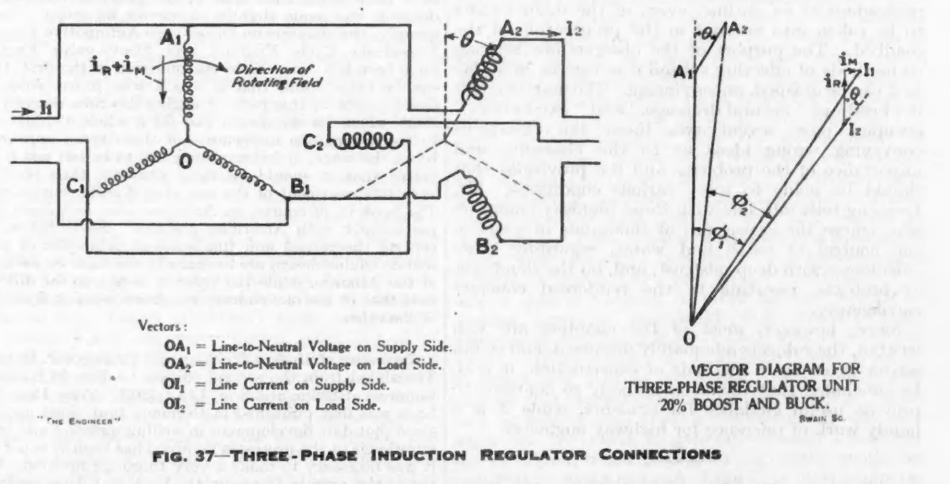

A_1
i_R+i_M
Direction of Rotating Field
I_1
C_2
O
C_1
B_1
θ
A_2
I_2
B_2
Vectors:
OA_1 = Line-to-Neutral Voltage on Supply Side.
OA_2 = Line-to-Neutral Voltage on Load Side.
OI_1 = Line Current on Supply Side.
OI_2 = Line Current on Load Side.
"The Engineer"
θ
A_2
A_1
i_M
I_1
i_R
θ
I_2
ϕ_2
ϕ_1
O
VECTOR DIAGRAM FOR THREE-PHASE REGULATOR UNIT 20% BOOST AND BUCK.
Swain Sc.

Fig. 37—Three-Phase Induction Regulator Connections

Three-phase Induction Regulators.

A diagrammatic representation of the windings of the most common form of three-phase induction regulator is given in Fig. 37. O A_1, O B_1, and O C_1 are the star-connected shunt windings carried by the rotor, and A_1 A_2, B_1 B_2, C_1 C_2 are the corresponding series windings housed in the stator. By altering the angular position of the rotor, and thereby causing a phase shift variation in the line pressure is produced without an alteration of the magnitude of the voltages in the series windings. The angle θ represents the displacement of the rotor from the maximum boost position, *i.e.*, that in which the axes of corresponding shunt and series windings coincide, the direction of the rotating field being assumed to be clockwise. In Fig. 37 the line to neutral vector diagram shows the pressure and current relationships corresponding to the position of the rotor, and relates to a Switchgear and Cowans regulator capable of giving a buck or boost of 20 per cent. As internal resistance and leakage reactance voltage drops are of as little importance as they are in a case of a single-phase regulator, they are not included, but the vector of magnetising current i_M is shown for the purpose of indicating its relationship with the rotor current I_R in the shunt windings.

Movement of the rotor from the maximum boost position to the full buck position involving rotation through 180 electrical degrees, may be made in a clockwise or anti-clockwise direction, but when the phase rotation is clockwise an anti-clockwise movement is preferable from the point of view of copper losses in the shunt winding. If the rotor is turned in the unfavourable direction i_R in its angular movement with respect to O I_2 eventually coincides in phase with i_M. The difference between the power factor on the supply and load sides of the regulator is caused by the magnetising current and the internal leakage impedance drop, which is not shown in the vector diagram, Fig. 37. The phase difference θ between the supply voltage O A_1 and the series winding boost A_1 A_2, introduces an equal phase shift in line voltage and current which is not objectionable when the system on one side of the regulator is only connected to the system on the other side through the regulator and in no other way.

Twin Induction Regulators.

By the use of two regulators, however, as shown in Fig. 38, the phase difference between the voltages on the two sides of the regulator may be obviated. Each regulator has half the required total capacity, and the voltage phase shift of one is in the opposite sense to that of the other. As the boost windings of the two regulators are in series and have the same induced voltages, their resultant effect is to give a voltage boost in phase with the line voltage, as shown in Fig. 38. Alternatively, the phase difference may be overcome by installing a polyphase bank of single-phase units, which, in some cases, is cheaper.

Induction Regulator Construction.

The general construction of induction regulators resembles, as most engineers know, that of wound rotor induction motors. Individual manufacturers may naturally claim special points, but, broadly speaking, all these regulators consist of a laminated stator core with windings and a rotor composed of a wound laminated core mounted on a shaft. Generally, they are oil-immersed in welded boiler plate tanks. The stresses imposed on the insulation depends on the severity of line surges prevalent. Switchgear and Cowans regulators are designed to withstand short circuits up to a maximum of twenty times the full load current for two seconds, or even more severe short circuit conditions if necessary.

All regulators of this kind may be hand, remote or automatically controlled. Hand control is fitted on all regulators made by the above firm, and serves in the cases of remote and automatic-controlled equipments as a standby. When a regulator is intended for hand control alone, a hand wheel is fitted either direct to the worm gearing shaft on the top plate, or through suitable shafts, bevels, and pinions in the case of remote mechanical control. The rotor of a remote electrically controlled regulator is moved by means of motor controlled by hand from a switchboard, or by conveniently situated push-buttons, the motor being arranged to drive the shaft through gearing. Under full load conditions the maximum torque possible is equal to that of an induction motor of the same kVA and number of poles. In a single-phase regulator a resultant pulsating torque exists when the power factor is less than unity, and when the regulator is not in either of its extreme positions. It is, therefore, necessary to make the operating gear self-locking, which is done by the use of worm gearing with a worm thread angle not exceeding 4 deg. On motor-operated regulators provided with this gear, convenient speed reductions, such as 1000 to 1, are readily obtained. Over-travel of the rotor of motor-operated regulators due to inertia can be prevented when necessary by a magnetic brake. Limit switches and mechanical stops prevent the rotor moving beyond its range, which, in the case of a two-pole regulator, is 180 deg.

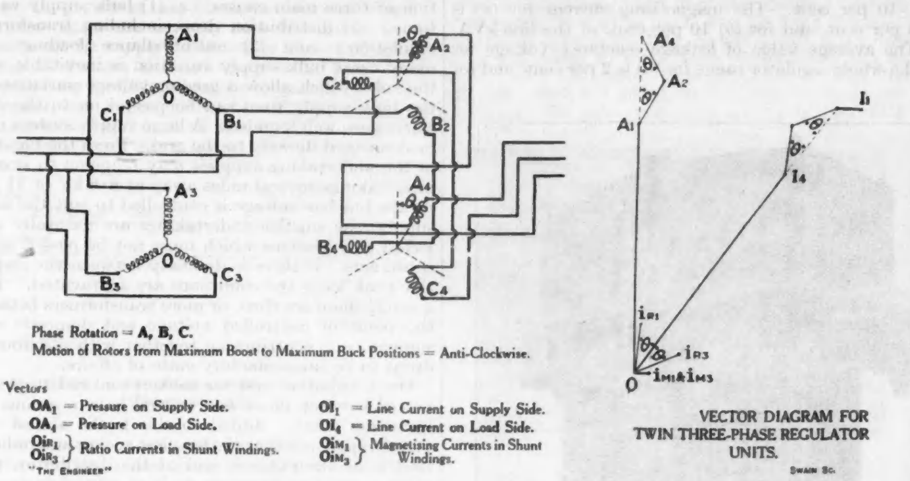

A₁
C₁
B₁
O
A₃
B₃
C₃
C₂
A₂
B₂
A₄
B₄
C₄
A₄
A₂
A₁
I₁
I₄
i_R1
i_R3
i_M1&i_M3
O
Phase Rotation = A, B, C.
Motion of Rotors from Maximum Boost to Maximum Buck Positions = Anti-Clockwise.
Vectors
OA₁ = Pressure on Supply Side.
OA₄ = Pressure on Load Side.
Oi_R1, Oi_R3 } Ratio Currents in Shunt Windings.
OI₁ = Line Current on Supply Side.
OI₄ = Line Current on Load Side.
Oi_M1, Oi_M3 } Magnetising Currents in Shunt Windings.
"The Engineer"
VECTOR DIAGRAM FOR TWIN THREE-PHASE REGULATOR UNITS.
Swain Sc.

Fig. 38—Twin Three-Phase Induction Regulator Connections

Automatic Control.

Induction regulators may readily be automatically controlled by means of relays. The modern Switchgear and Cowans relay is fitted with two pairs of sparkless contacts, which are normally open. Intermediate contactors are interposed between the voltage and the main motor operating contactors, the coils of the smaller contactors being shunted by a condenser so as to reduce the duty of the voltage relay contacts. In the case of simple feeder control the function of the automatic voltage relay is to close the operating motor circuit when the voltage deviates by 1 per cent. or more from the correct value. On ring mains the relay may be required to operate when a difference occurs between two voltages, and the beam of the regulator is then controlled by two opposing forces produced differentially, phase differences having no effect.

Line Drop Compensators.

By passing a current in phase and proportional to the line current through an impedance a voltage drop is obtained corresponding to the line voltage drop, the impedance being adjusted to correspond with the line constants. Such an arrangement is known as a line drop compensator, but it does not apply to circuits in which considerable loads are taken from the feeder between the regulator and remote points at which voltage regulation is required. The diagram, Fig. 39, shows a three-phase regulated line with an automatically controlled induction regulator. With equilateral triangular spacing of three-phase conductors the reactance drop for any two conductors is solely determined by the currents in these conductors. Thus if, as shown in Fig. 39, two current transformers with their primaries in two phases of the system and with their secondaries cross connected feed a line drop compensator, a voltage drop in phase with and proportional to the voltage drop between the two phase conductors is obtained. But, when the spacing of the three-phase conductors is not symmetrical, the line drop compensator supply system will necessarily be more intricate. Adjustment of the apparatus for line capacity may be made, when necessary, by means of the potential transformer P.T.

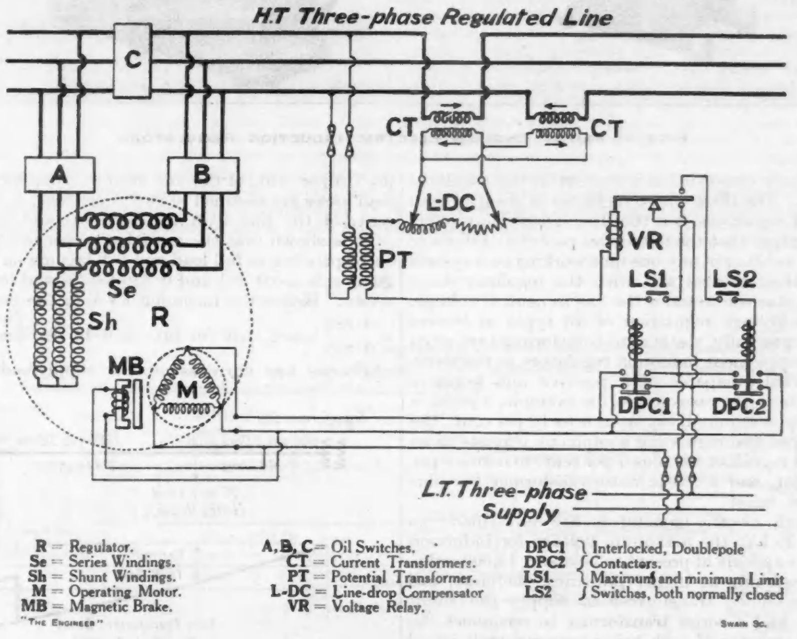
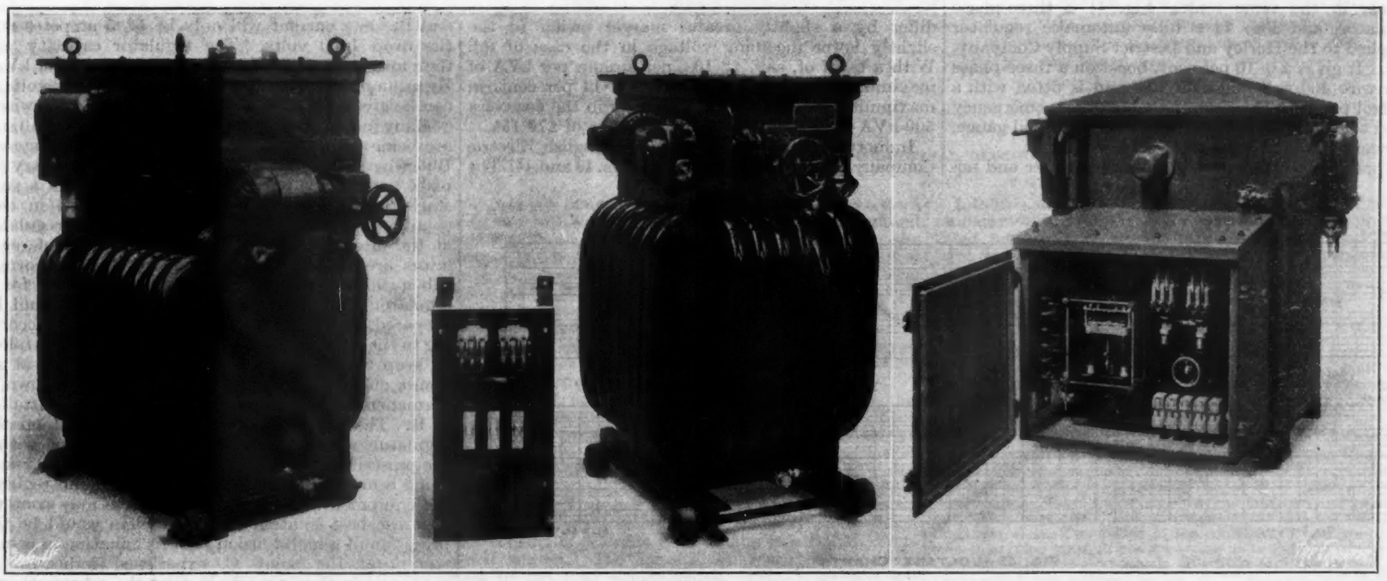

H.T Three-phase Regulated Line
C
CT
CT
A
B
L-DC
VR
PT
Se
Sh
R
MB
M
LS1
LS2
DPC1
DPC2
L.T. Three-phase Supply
R = Regulator.
Se = Series Windings.
Sh = Shunt Windings.
M = Operating Motor.
MB = Magnetic Brake.
A, B, C = Oil Switches.
CT = Current Transformers.
PT = Potential Transformer.
L-DC = Line-drop Compensator
VR = Voltage Relay.
DPC1, DPC2 } Interlocked, Doublepole Contactors.
LS1, LS2 } Maximum and minimum Limit Switches, both normally closed
"The Engineer"
Swain Sc.

Fig. 39—Automatically-Controlled Three-Phase Induction Regulator

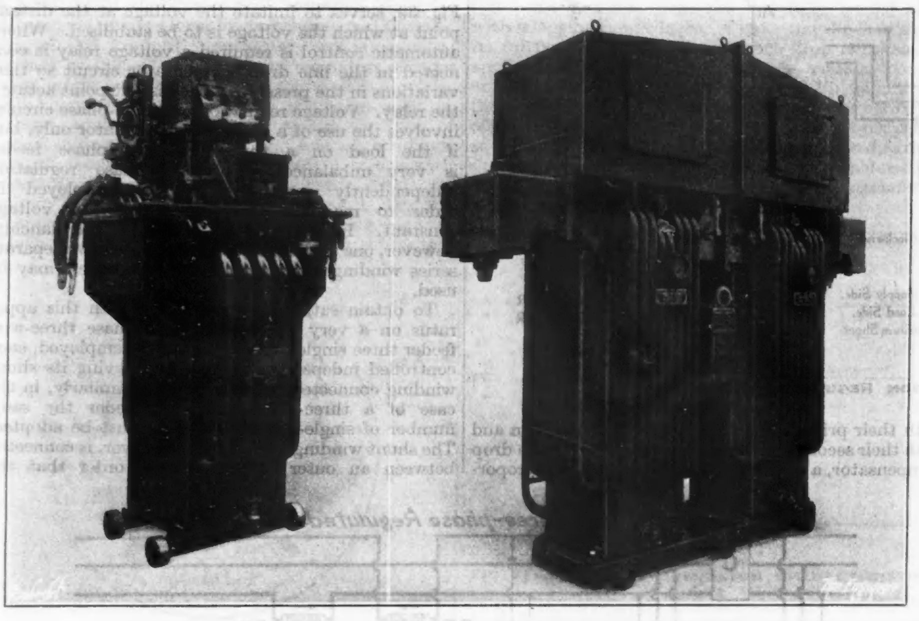
The Application of Induction Regulators.

On a dead end feeder the induction regulator is introduced to compensate for fluctuations of pressure on the supply side and also for the drop in the feeder produced by load current, and it may be installed at any convenient point. A line drop compensator used in conjunction with a potential transformer connected on the load side of the regulator, as shown in Fig. 39, serves to imitate the voltage at the distant point at which the voltage is to be stabilised. Where automatic control is required a voltage relay is connected in the line drop compensator circuit so that variations in the pressure at the distant point actuate the relay. Voltage regulation on single-phase circuits involves the use of a single-phase regulator only, but if the load on a three-wire single-phase feeder is very unbalanced two single-phase regulators independently controlled may be employed in order to maintain the line to neutral voltage constant. In the absence of serious unbalancing, however, one single-phase regulator with two separate series windings connected in the two outers may be used.

To obtain satisfactory regulation with this apparatus on a very unbalanced three-phase three-wire feeder three single-phase units can be employed, each controlled independently and each having its shunt winding connected between lines. Similarly, in the case of a three-phase four-wire feeder the same number of single-phase regulators must be adopted. The shunt winding of each unit, however, is connected between an outer and neutral in order that the voltages between these conductors may be maintained constant for any load condition within the limits of the regulator range. Sufficiently close voltage regulation on three-wire single-phase and four-wire three-phase systems may, however, be obtained by a single regulator and a static balancer connected at a point as close as possible to the



Figs. 40 to 42—Switchgear and Cowans Induction Regulators unbalanced load. When serious unbalancing does not occur on a three-phase feeder the three-phase unit is applicable as an alternative to three single-phase units, and in the case of a three-phase four-wire feeder it is necessary to connect the star point of a star-connected three-phase unit or a three-phase regulator bank to the fourth wire of the feeder in order to provide a path for any out-of-balance current in the regulator windings. The three-phase regulator is cheaper than a bank of regulators, but the three-phase bank offers the advantage that the maximum potential difference normally existing in any one unit working on a system with earthed neutral and with the regulator shunt windings star connected is the line to neutral voltage.



FIGS. 43 AND 44—ENGLISH ELECTRIC INDUCTION REGULATORS

In the voltage regulation of all types of feeders and lines generally, static auto-transformers are often used to supplement induction regulators, as the latter are inherently capable of a positive and negative boost. Hence, in cases where, for example, a positive boost only is required, say from 0 to 10 per cent., the most economical regulating equipment consists of an induction regulator for plus 5 per cent. to minus 5 per cent. boost, and a static auto-transformer for plus 5 per cent. boost.

Although electric generators are now made to work at 36 kV, the maximum voltage for induction regulators appears at present to be about 14,000 volts. Circuits working at higher pressures, therefore, call for a step-down transformer to supply the shunt windings and a series transformer to reconnect the line, the capacity of each being approximately equal to that of the regulator. On lower voltage circuits on which the ratio of voltage to internal kVA is too large to make a directly connected regulator economical, transformers may also be required. Examples of Switchgear and Cowans automatic induction regulators are illustrated in Figs. 40 to 42. The first shows a single-phase regulator with an auto-transformer in the same tank; Fig. 41 a three-phase regulator, and Fig. 42 a fully automatic regulator supplied to the Horley and District Supply Company, Ltd. It gives a 0–10 per cent. boost on a three-phase four-wire 400-volt 100-kVA line and is fitted with a control panel on the side of the tank, an emergency hand wheel, oil filling valve, oil drain valve, oil gauge, thermometer, and removable cable boxes.

Apart from tap-changing gear, the copper and no-load losses, magnetising kVA and leakage reactance are claimed to be smaller on these regulators than on any other type. Large magnetising kVA and leakage reactance will lower the line power factor and thereby give rise to increased line copper losses and increased maximum kVA demands. For the sake of illustration the makers of these regulators make a comparison of (*a*) an induction regulator, and (*b*) a regulator of no particular make having an extremely large magnetising kVA and reactance, both designed for a boost of ±10 per cent. The magnetising current for (*a*) is 3 per cent. and for (*b*) 10 per cent. of the line kVA. The average value of leakage reactance voltage for the whole regulator range for (*a*) is 2 per cent. and for (*b*) 7·5 per cent. of the line voltage. Copper and no-load losses are assumed to be 0·5 per cent. and 0·2 per cent. of the line kVA for both (*a*) and (*b*).

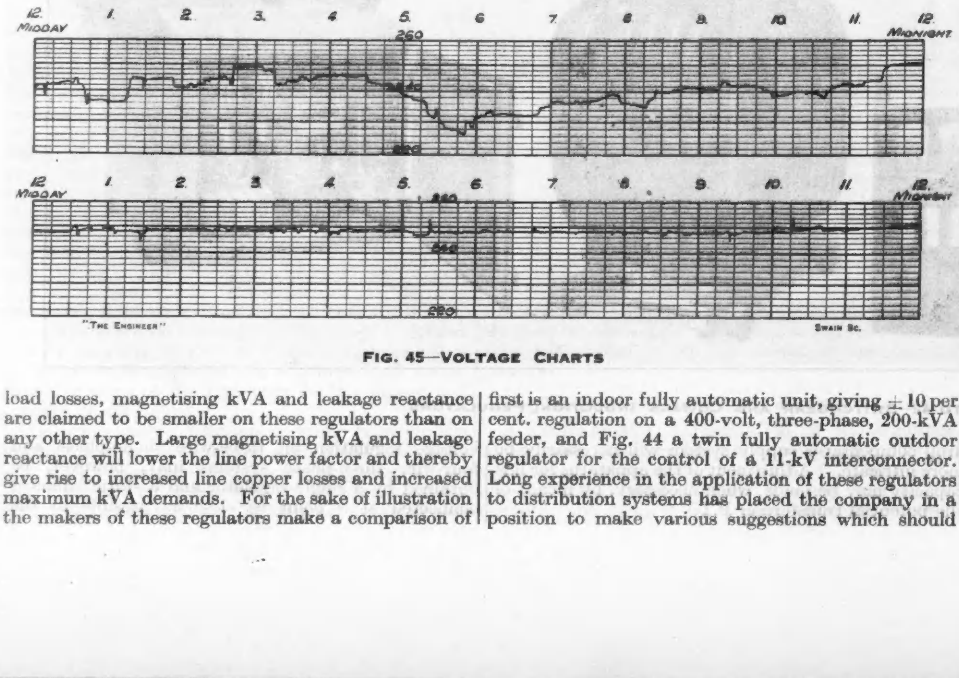


FIG. 45—VOLTAGE CHARTS

It is shown that the incoming power factor values corresponding to full load and 0·9 lagging on the outgoing side are 0·881 and 0·830 for (*a*) and (*b*) respectively. Hence the incoming kVA in the case of (*b*) is $\frac{0\cdot881}{0\cdot830}$ times that for (*a*), or 6·14 per cent. more, while the line currents on the supply side would differ by a slightly greater margin owing to the slightly lower incoming voltage in the case of (*b*). With a tariff of, say, £2 10s. per annum per kVA of maximum demand a difference of 6·14 per cent. in maximum kVA demand would mean in the case of a 500-kVA feeder an extra annual charge of £76 15s.

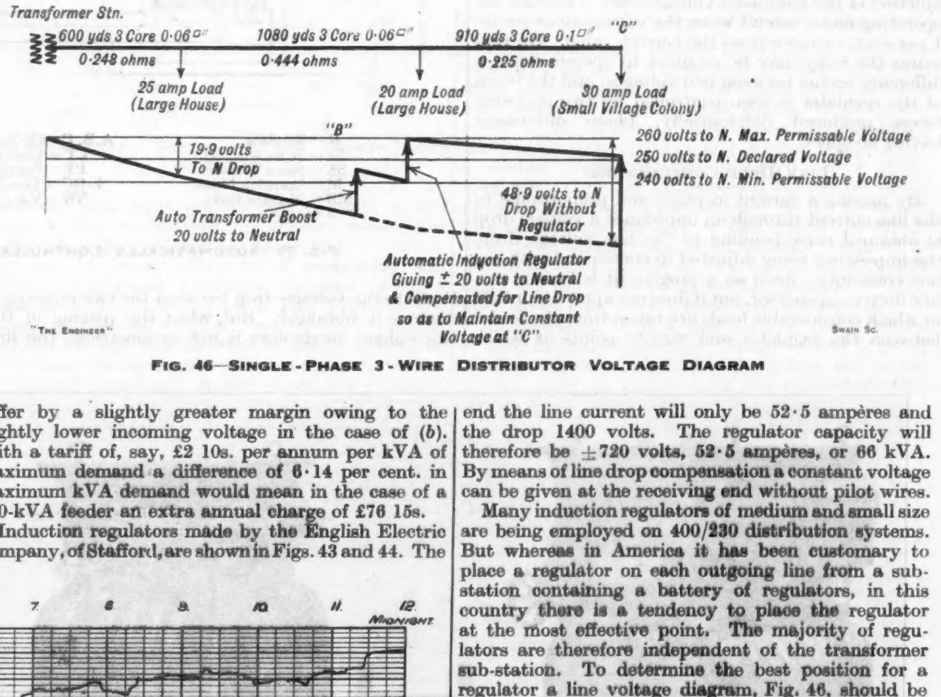

Transformer Stn.
600 yds 3 Core 0·06 □''
0·248 ohms
1080 yds 3 Core 0·06 □''
0·444 ohms
910 yds 3 Core 0·1 □''
0·225 ohms
"C"
25 amp Load (Large House)
20 amp Load (Large House)
30 amp Load (Small Village Colony)
"B"
19·9 volts To N Drop
260 volts to N. Max. Permissable Voltage
250 volts to N. Declared Voltage
240 volts to N. Min. Permissable Voltage
48·9 volts to N Drop Without Regulator
Auto Transformer Boost 20 volts to Neutral
Automatic Induction Regulator Giving ± 20 volts to Neutral & Compensated for Line Drop so as to Maintain Constant Voltage at "C"
"THE ENGINEER"
SWAIN SC.

FIG. 46—SINGLE-PHASE 3-WIRE DISTRIBUTOR VOLTAGE DIAGRAM

Induction regulators made by the English Electric Company, of Stafford, are shown in Figs. 43 and 44. The first is an indoor fully automatic unit, giving ±10 per cent. regulation on a 400-volt, three-phase, 200-kVA feeder, and Fig. 44 a twin fully automatic outdoor regulator for the control of a 11-kV interconnector. Long experience in the application of these regulators to distribution systems has placed the company in a position to make various suggestions which should appeal to distribution engineers. Unsatisfactory voltage regulation at consumers' terminals may, as explained at the outset, be due to one or a combination of three main causes, *i.e.* (1) bulk supply variations; (2) distribution drop, including transformer regulation; and (3) out-of-balance loading. In many cases bulk supply variation is inevitable, and the rules which allow a greater voltage variation on the bulk supply than can be passed on to the consumers are well founded. A large supply system may be connected directly to the grid. From the bus-bars of the undertaking supplies may be given to smaller undertakings several miles away at 6·6 kV or 11 kV. As the bus-bar voltage is controlled to suit the main supply, the smaller undertakings are naturally subjected to variations which must not be passed on to consumers. If there is diversity between the respective peak loads the conditions are aggravated. Frequently there are three or more transformers between the point of controlled voltage and domestic consumers, each contributing together with distribution drops to an unsatisfactory state of affairs.

On distribution systems cookers and radiators connected between phase and neutral have a serious unbalancing effect. Added to this is the almost universal experience that the heaviest cooker and radiator load is at the extreme end of the distributor, thus causing the maximum neutral conductor drop. All of these items have probably contributed to the unsatisfactory conditions indicated in the upper voltage chart shown in Fig. 45, which is a voltage curve taken under actual practical conditions. The lower record, Fig. 45, shows the effect of installing a regulator.

POSITION OF REGULATOR.

When small undertakings receive a bulk supply from a larger undertaking without tee connections, the outgoing panels on the bulk supply switchboard are usually separated from the local feeder panels by a metering panel, so that the bulk supply for the distant area, which may be several miles away, is metered at the sending end. In the majority of such cases it is most economical to arrange for the regulator at the sending end, particularly if for the most part the voltage variation is due to drop on the interconnector feeder. Assuming that it is required to receive 1000 kVA at 11,000 volts, 52 ampères, and that for this load the line has a drop of 1760 volts, before regulation the received load will be at 9240 volts, 64 ampères. The induction regulator must therefore be built for ±880 volts, 64 ampères, or 97·7 kVA. But if the regulator is at the sending end the line current will only be 52·5 ampères and the drop 1400 volts. The regulator capacity will therefore be ±720 volts, 52·5 ampères, or 66 kVA. By means of line drop compensation a constant voltage can be given at the receiving end without pilot wires.

Many induction regulators of medium and small size are being employed on 400/230 distribution systems. But whereas in America it has been customary to place a regulator on each outgoing line from a sub-station containing a battery of regulators, in this country there is a tendency to place the regulator at the most effective point. The majority of regulators are therefore independent of the transformer sub-station. To determine the best position for a regulator a line voltage diagram, Fig. 46, should be prepared, giving the drops along each section, according to the load distribution, to enable steps to be taken to keep the voltage within the desired limits at all points on the distributor. In the example shown, a permanent step auto-transformer has been installed at B. This permits of both buck and boost on the regulator, and helps to keep the line voltage within the prescribed limits throughout its length, the result being a more economical use of the line and regulating equipment. While some engineers may contend that the best solution of the problem would be the provision of a high-tension line, terminating in a sub-station at the point C, experience indicates, as explained in the first article, that the scheme shown in Fig. 46 is often preferable. Even if the additional initial cost of the high-tension line appears to be justified by possible future developments, it has repeatedly been found that regulating gear has postponed the necessary new sub-stations for several years. The cost involved has not been more than a few years' interest on the ultimate capital outlay.

In the meantime the direction of load development can be studied and definite plans may be made for the future. When load development demands a sub-station, the regulator may be moved to another spot.

In some cases the capacity of a distributor is increased and the supply extended by terminating the existing conductors at a new distribution pillar, and by connecting a regulated feeder in parallel with the distributor, as shown in Fig. 47. Equal voltage is maintained at both ends of the feeder, so that the existing conductors draw energy in both directions, and the capacity is virtually doubled. A new distribution centre is also created. A twin induction regulator will, of course, be required as phase shift is not permissible. Regulator devices having a large reactive component must also be avoided on account of circulating current.

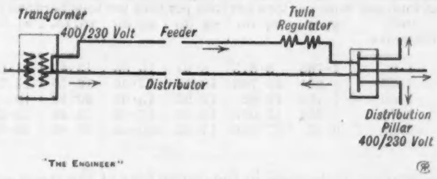


FIG. 47—REGULATED FEEDER IN PARALLEL WITH DISTRIBUTOR

In cities and towns in which sub-station sites are very costly and often difficult to obtain, saving in capital may become possible by adopting the scheme shown in Fig. 48. A large sub-station at A is equipped with transformers and regulators. From this sub-station feeders radiate to centres X, Y and Z, and line drop compensation is provided to give constant voltage at these points, irrespective of the load. The feeder cables can be run at their maximum economic loading, as voltage drop does not enter into consideration. Compared with the cost of two or three sub-stations erected on expensive sites, the single sub-station and its equipment, illustrated in Fig. 48, shows marked financial advantage. Service is also improved, as correction is made for high-tension variation and transformer regulation.

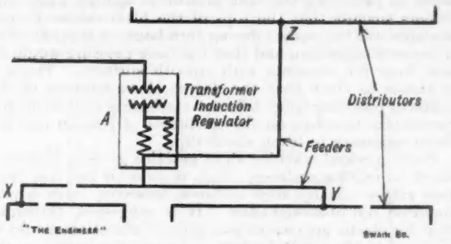


FIG. 48—INDUCTION REGULATOR IN SUB-STATION

LOSS DUE TO LOW VOLTAGE.

The importance of good regulation is well exemplified by a case cited by the English Electric Company. In a certain district a large number of cookers were returned because they were unsatisfactory, whereas in neighbouring districts deriving current from the same source they were highly praised. Bad voltage regulation proved to be the cause of the complaints, but the installation of induction regulators eventually led to the re-installation of the cookers, which are now giving entire satisfaction.

The loss of revenue to supply undertakings when the voltage is low was mentioned in the first article, where it was stated that the watt consumption of lamps may be taken as a reduction of 1·5 per cent. for each 1 per cent. reduction in voltage, and that of heating appliances 2 per cent. under the same conditions. Assuming a 100-kVA load, with an overall load factor of 28 per cent., made up of one-third lighting, one-third heating, and one-third of appliances such as water heaters, in which the consumption is not affected by voltage variations, a drop in voltage of 10 per cent. will have the following result :—

Units per annum at normal voltage	246,000	
Lighting units p.a. at 10 per cent. reduced voltage		69,700
Heating units p.a. at 10 per cent. reduced voltage		65,600
Unaffected units p.a. at 10 per cent. reduced voltage		82,000
	217,300	217,300
Lost revenue for	28,700	

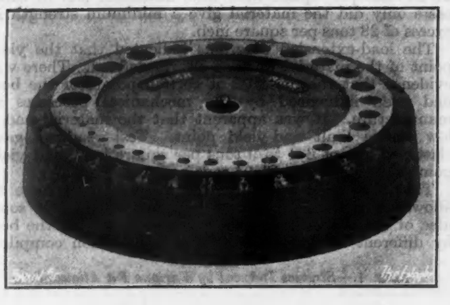
If it be assumed that the whole of these lost units are on a fixed charge of 0·75d., and the unit charge to the supply authorities is 0·30d., there will be 28,700 units at 0·45d.=£53 16s. lost revenue. Although these calculations are on a very conservative basis, they serve to show that the necessary regulator would pay its capital cost in less than two years.

(To be continued.)

ACCORDING to the latest information, it is expected that new telephone cables between India and Ceylon will be laid by March next year.

A Die-cast Drill Stand.

THE accompanying block illustrates clearly a neat bit of die-casting in a white metal done by Fry's (London), Ltd., 24/25, King-street, E.1. As will be seen it is a drill stand, and owing to the absence of machining can be retailed at a low price. It is painted green with the drill sizes raised and gilded, so that they are easily distinguished. The holes range from ⅛in. up to ½in., rising by 64ths, and we have found that standard drills are a comfortable fit. The casting is, we need hardly say, hollow below, but is provided with a local protrusion to accommodate the drill holes. The diameter is 6in.



FRY'S DRILL STAND

Gaseous Discharge Lighting at Ilford.

THE recently completed installation of Mazda Mercra lighting in Romford-road, Ilford, marks another step in the progress of gaseous discharge lamps. Most of the previous installations of the kind have been on arterial roads, where the colour of the light is not an important factor, but the Ilford installation is said to afford evidence that the new system of illumination is also satisfactory in urban districts. The stretch of the Romford-road on which the lamps have been installed is about ¼ mile long, and the open space at Seven Kings Station has been similarly equipped. Owing to the great width of the road and the disposition of the tramway standards carrying the lamps considerable difficulty was previously experienced in providing satisfactory illumination in the area outside the station. The use of Mazda Mercra lamps in B.T.H. circular lanterns giving a wide dispersion of light has, however, solved the problem. Adequate illumination over the whole area is said to have been obtained without changing the position of the units, although much better results could have been secured if this had been possible.

The B.T.H. circular lanterns used for illuminating this particular area have been designed for illuminating open spaces, such as railway yards, docks, car parks, &c., on which a good spread of well-diffused illumination is required. Essentially the fitting consists of an over-reflector and a cylindrical opal glass suitably ventilated.

On the Romford-road section of the installation thirteen lighting units are attached to the tramway posts. Each unit consists of a Mazda Mercra lamp in a B.T.H. directional lantern. The lanterns are spaced on alternate sides of the road approximately 120ft. apart and are mounted at a height of 20ft. According to the kind of light distribution required the B.T.H. directional lanterns are made in several patterns, and the type used in the Romford-road installation is designed to give equal illumination up and down the road, but a greater intensity across the road than on the pavement.

Notwithstanding the low mounting height of the lanterns, the illumination on the road surface is said to be remarkably uniform and there is an entire absence of the patchiness frequently associated with the use of large units. A series of foot-candle tests has been taken between posts and it has been found that, in spite of the fact that the mounting of the units is much too low for units of the size employed, the uniformity of illumination is remarkably good.

The Industrial Machine.

By D. DIXON.

THE accompanying diagram of the industrial machine illustrates the causes of the trade depression and the immediate needs of industry.

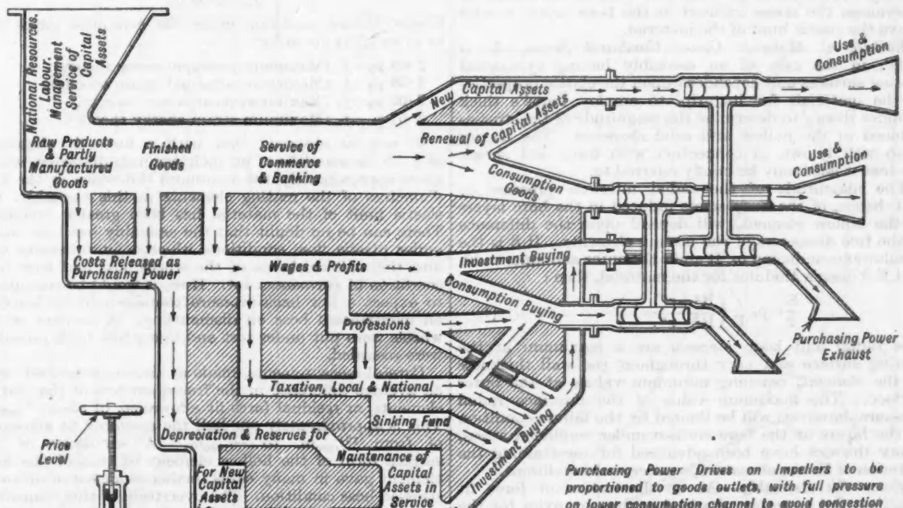
The total costs of industry in the form of wages, salaries and profits, payments for raw materials which become wages, salaries and profits, together with rents, interest and reserve charges, equal the price of the total product. Those costs must be distributed as purchasing power to provide the demand for the product, and the purchasing power must be used and exhausted if the demand is to be adequate and production is to continue.

Furthermore, it must be suitably proportioned between investment purchase and consumption purchase. Excessive saving for investment purchase from large incomes, or from small incomes to provide old age security, means too great a demand for investment products, which cannot, however, be bought profitably and used for continued and profitable production as the consumption demand is inadequate. The machine therefore becomes congested and slows. A stronger pull on the consumption channel from wages and salaries is necessary and a weaker pull from investment buying on the investment goods channel.

Moreover, the investment demand can be maintained less from unearned rents, debt interest and high profits and more from the channel fed from reserve charges.

The continuous increase in reserve charges to provide for future increased machine power means also a continuous lag in the necessary total of investment and consumption purchasing power. The extent to which reservation for new equipment exceeds expenditure on equipment must be offset by new money from central banking organisations, with price level of a range of basic commodities as a valve for the amount. It is thus an increase of money concurrent with increase of total wealth to prevent deflation and keep prices reasonably stable.

Improved trade depends on a substantial and general lift in the standard of living and a managed money system independent of gold.


National Resources.
Labour.
Management
Service of Capital Assets
Raw Products & Partly Manufactured Goods
Finished Goods
Service of Commerce & Banking
New Capital Assets
Renewal of Capital Assets
Use & Consumption
Consumption Goods
Use & Consumption
Costs Released as Purchasing Power
Wages & Profits
Investment Buying
Consumption Buying
Professions
Taxation, Local & National
Sinking Fund
Depreciation & Reserves for
For New Capital Assets i.e. Increased M/cs etc.
Maintenance of Capital Assets in Service
Investment Buying
Purchasing Power Exhaust
Price Level
Central Banking Organisations
Input of New Money to Co-ordinate with Increased Machine Power & Increased Productivity
"THE ENGINEER"

Purchasing Power Drives on Impellers to be proportioned to goods outlets, with full pressure on lower consumption channel to avoid congestion in main chamber and souring of Labour and Capital.

Price Level Valve to control pressure from new money inlet on upper investment level, to offset costs delayed as purchasing power.

THE INDUSTRIAL MACHINE

International trade does not affect principle, as it is fundamentally an exchange of goods for goods—complicated by export of surplus investment goods and the import of income in the form of goods from investments and services.

LAUNCHES AND TRIAL TRIPS.

CELERITY, steel coal barge, 130 tons displacement; built by Richard Dunston, Ltd., to the order of Yorkshire owners; launch, December 2nd.

ASSOCIATION OF CONSULTING ENGINEERS.—The annual dinner of the Association of Consulting Engineers (Incorporated) was held on Thursday, December 7th, at St. Stephen's Club, Westminster. There was a large party of members and guests, numbering over 180. The chairman was Mr. A. M. Sellar, Chairman of the Committee of the Association, who presided over an evening which in every way was up to the high standard the Association has established. The toast of "The Houses of Parliament" was proposed by Mr. W. T. Halcrow, and replies were made by Lord Meston and Sir Edward T. Campbell. The toast of "British Engineers" was ably proposed by Major Sir Archibald Boyd-Carpenter, and response was fittingly made by Mr. Alan E. L. Chorlton, President of the Institution of Mechanical Engineers, and Sir Cyril Kirkpatrick, Past-president of the Institution of Civil Engineers. The last toast, "The Association of Consulting Engineers," was entrusted to Sir Lynden L. Macassy, and the Chairman, Mr. A. M. Sillar briefly replied.

Force, Shrink and Expansion Fits.*

By ROBERT RUSSELL, B.Sc., A.M.I. Mech. E.

Introduction.—The transmission of power by elements having cylindrical mating surfaces has for long been successfully effected by an assmbly in which keyways and key seats were cut on the surfaces and a key inserted between the elements. The development of high-speed machinery, however, created a set of conditions in the hollow element or wheel which could not be met successfully by such an assembly. A tendency for it to become loose upon the shaft or solid element, due to an increase in the size of the bore under centrifugal action, could only be successfully prevented by an assembly which induces in the material surrounding the bore elastic strains and stresses in excess of those to which the wheel would be subjected at the maximum speed of rotation. Such an assembly, making use of the elastic properties of the mating materials, would require the free diameter of the solid element to be slightly bigger than the free diameter of the hollow element. Where there is a fit allowance or difference in the free diameters of the cylindrical mating surfaces, the assembly may be made, by heating the outer or hollow element, as a shrink fit; or it may be made by pressing the hollow element over the solid element as in force fit practice. The elastic grip between the mating elements may also be established by cooling the inner or solid element to an extremely low temperature by immersion in a refrigerant, and then allowing it to grip the hollow element as an expansion fit.

Information is required which would lead to the standardisation of the procedure adopted in the making of such assemblies. The failure of the early turbine discs to maintain their grip due to the reduction of the radial interface pressure to zero, the loosening of drums on shafts due to temperature effects, the slipping of pins and journals in crank webs, and the loosening of tires on locomotive wheels have all resulted in a technique of a higher order in making the fit assembly. Workshop practice to-day is, however, so varied as to suggest that differences still exist in the minds of engineers regarding certain aspects of the subject, a state of affairs which is far from satisfactory. The nature of the finish of the mating surfaces differs widely. They may be machined, but unpolished, and not very smooth, they may be turned or ground, or they may be dry-scraped or wet-scraped and given a high polish. The fit allowance would appear to vary within wide limits. For example, a certain shrink fit assembly has fit allowances ranging between 1 and 1·75 thousandths of an inch per inch diameter for the same quality of material, and the results appear to be equally successful, despite the fact that at the higher fit allowances the stress induced in the bore layers is well above the elastic limit of the material.

Failure of Material Under Combined Stress.—It is usual, in the case of an assembly having cylindrical mating surfaces and dependent upon the elastic properties of the materials for its grip, to employ Lamé's thick cylinder theory to determine the magnitude of the stresses induced in the hollow and solid elements. The theory is so well known in connection with force and shrink fits that it need only be briefly referred to.

The magnitude of the radial interface pressure p_r and, hence, of the hoop stress induced in the bore layers of the hollow element, will depend upon the difference in the free diameters of the mating elements. If S is the fit allowance inducing p_r, R and r the outer and inner radii, and E Young's Modulus for the material, then:

$$\frac{S}{2}=p_r\,\frac{r}{E}\left(\frac{R^2+r^2}{R^2-r^2}+1\right) \quad . \quad . \quad . \quad . \quad (1)$$

The radial and hoop stresses are a maximum at the mating surface and vary throughout the wall thickness of the element, reaching minimum values at the outer surface. The maximum value of the interface radial pressure, however, will be limited by the failure condition of the layers at the bore surface under combined stress. Many theories have been advanced for ascertaining the criterion of failure of materials under such conditions.

Force Fit Assembly.—As an illustration of force fit practice, the assembly of wheel centres on axles for the standard 12-ton mineral wagon will be considered. The axles are made either of acid open-hearth or basic open-hearth steel with an ultimate tensile stress of 35–40 tons per square inch.† The wheel seat, according to specification, must be turned with a smooth finish, and be either parallel or having a taper of not more than $^{3}/_{1000}$in. The boss of the wheel centre must be bored with a smooth finish, and the hole and wheel seat coated with a suitable lubricant, preferably pure rape oil. The wheel centre, when untired, is forced on to its seat by hydraulic power with a pressure of not less than 60 tons and not more than 80 tons. For tired wheel centres it is assumed that a load is imparted to the wheel boss by the shrinkage of the tire on the rim and an extra 10 tons in each case is allowed. It is important to note that in this assembly the Railway Clearing House specify a minimum and maximum axial tonnage, but make no reference whatever to a force fit allowance for the mating elements.

Quality of Material in Elastic Grip Assemblies.—As has been mentioned, the Railway Clearing House specify a tonnage instead of a fit allowance in pressing wheels on their seats. This tonnage is obtained in practice by a method of trial and error. Wheels are bored with a given fit allowance, based on experience of similar work, and the fit which gives the specified tonnage determines the dimensions for the mating assembly. The specification and the method of conforming to it are both open to serious objection. If no consideration is given to the physical properties of the material, the fit allowance may result in an overstressed boss and a diminished grip between the mating elements. Test pieces taken from the web of wheel centres must, according to the specification, show a tensile breaking strength of not less than 28 tons per square inch. No reference is made to the elastic limit or yield point of the material. Yet the stress-strain proportional limit is the factor which should determine the fit allowance and the suitability of the material for an elastic grip assembly.

In order to get some idea of the quality of the material surrounding the bore, four tensile test pieces were machined from each of the bosses of wheel centres made from eight different casts. Two were taken circumferentially from the wheel boss and at right angles to one another. Two were taken from the boss parallel to the wheel bore and also at right angles to one another. The average values obtained from the four tests of each cast showed a great variation in the quality of the steel. Values as low as 24·38 tons per square inch were obtained, and in three casts only did the material give a minimum strength in excess of 28 tons per square inch.

The load-extension diagrams indicated that the yield point of the material was not clearly defined. There was evidence that the material at certain points of the boss had been influenced by the mechanical processes in manufacture. It was apparent that the material had a low elastic limit and yield point. Test readings gave elastic values of 6·4 to 9 tons per square inch, and yield point values of 11 to 16·04 tons per square inch.

This particular assembly was made with a force fit allowance of from $^{10}/_{1000}$in. to $^{12}/_{1000}$in., and to give some idea of the magnitude of the stresses induced in the boss by different fit allowances, Table I. has been compiled.

TABLE I.—*Stresses Induced by Various Fit Allowances.*

Force fit allowance.		Radial pressure.	Hoop Stress.	Principal stress theory	Principal strain theory	Shear stress theory	Strain energy theory
S/d thousandths of an inch per inch diameter.	S thousandths of an inch.	p_r tons per sq. in.	f_r tons per sq in..	f_L tons per sq. in.	f_L tons per sq. in.	f_L tons per sq. in.	f_L tons per sq. in.
0·75	4·13	3·242	6·78	6·78	7·75	10·02	8·33
1·00	5·5	4·322	9·03	9·03	10·33	13·36	11·11
1·25	6·88	5·403	11·29	11·29	12·91	16·69	13·89
1·50	8·25	6·483	13·55	13·55	15·50	20·04	16·66
1·75	9·73	7·563	15·81	15·81	18·07	23·37	19·44
2·00	11·0	8·644	18·06	18·06	20·65	26·71	22·21
2·25	12·38	9–725	20·32	20·32	23·25	30·05	25·00

Substituting for R and r in equation (1), the interface radial pressure intensity is given by:

$$p_r=4322\,\frac{S}{d}$$

and the hoop stress at the bore layer by

$$f_r=2·09\,p_r.$$

Elastic failure condition under the combined stress due to p_r and f_r is given by

$2·09\,p_r=f_L$ (Maximum principal stress theory).
$2·39\,p_r=f_L$ (Maximum principal strain theory).
$3·09\,p_r=f_L$ (Maximum shear stress theory).
$2·57\,p_r=f_L$ (Maximum strain energy theory).

It will be observed that with a force fit allowance of 1·75 thousandths of an inch per inch diameter, which gives approximately the minimum difference in the free diameters of the mating elements in this assembly, the elastic limit of the material has been greatly exceeded. There can be no doubt that the assembly has been made under plastic flow conditions which may penetrate well into the wall thickness of the wheel boss and lead to a condition of permanent set. If so, it would be reasonable to expect a low back-pressure tonnage and evidence of an overstressed boss on dismantling. A number of the wheels were put under test and many low back-pressures were recorded.

Careful measurements, made as already described, gave an average difference in the free diameters of the mating elements, or residual force fit allowance, of about $^{5}/_{1000}$in. This is approximately one-half the assembly fit allowance of from $^{10}/_{1000}$in. to $^{12}/_{1000}$in. A similarity of the surface form of the hollow element to that of the solid element gave in many cases further evidence of an overstressed boss condition. The overstrain of this element in some cases resulted in the bore diameter at the leading face of the boss being bigger than the wheel seat by $^{1}/_{1000}$in. to $^{2}/_{1000}$in. A pronounced out-of-roundness and out-of-straightness of the solid elements were also observed.

The author suggests that in specifying that the test piece is to be taken from the web of the wheel centre a part has been selected which will give higher elastic limit and yield point values than those obtained from the wheel boss. Doubt may be expressed as to which of these two parts is more severely stressed under running conditions.

It may be well, at this stage, in view of the experiments to be described later, to consider the fit allowances employed and the magnitude of the stresses induced in an important shrink fit assembly, a built-up crank shaft. Consider the web having dimensions such that $R/r=1·876$. Substituting R and r in equation (1), the interface radial pressure intensity is given by

$$p_r=4785\,\frac{S}{d}$$

and the hoop stress at the bore layer by

$$f_r=1·8\,p_r.$$

The elastic failure condition under the combined stress due to p_r and f_r is given by

$1·8\,p_r=f_L$ (maximum principal stress theory)
$2·1\,p_r=f_L$ (maximum principal strain theory)
$2·8\,p_r=f_L$ (maximum shear stress theory)
$2·3\,p_r=f_L$ (maximum strain energy theory).

The webs in such an assembly are generally made from a 28 to 32-ton rolled slab steel and the shrinkage allowance employed by crank shaft makers is between 1 and 1·75 thousandths of an inch per inch diameter. It will be observed from Table II. that a shrinkage allowance of 1·75 thousandths of an inch per inch diameter would require the elastic limit to be not less than 19·26 tons per square inch. An elastic condition of this order obtained in the case of the force fit assembly having a fit allowance of 1·75 thousandths of an inch per inch diameter.

This is a figure associated with steel of high quality and is much in excess of that obtained from a 28 to 32-ton steel. Load extension curves obtained from test pieces taken from a steel bloom before being rolled into slabs for crank webs gave an average elastic limit value of 9·5 tons per square inch. This material may be regarded as representative of the quality of the steel in the centre part of the crank web which has had comparatively little work done on it during rolling. The high shrinkage allowance, therefore, adopted by some crank shaft makers is bound to introduce plastic or semi-plastic conditions well into the wall thickness of the web material. It is suggested, based on experimental evidence to be discussed later, that a successful shrinkage assembly may be effected with the wall thickness of the hollow element entirely within the elastic range of the material.

TABLE II.—*Stresses Induced by Various Shrinkage Allowances.*

Shrinkage allowance.	Radial pressure.	Hoop stress.	Principal stress theory.	Principal strain theory.	Shear stress theory.	Strain energy theory.
S/d thousandths of an inch per inch diameter.	p_r tons per sq. in.	f_r tons per sq. in.	f_L tons per sq. in.	f_L tons per sq. in.	f_L tons per sq. in.	f_L tons per sq. in.
1·0	4·785	8·613	8·61	10·05	13·40	11·01
1·25	5·981	10·766	10·77	12·56	16·75	13·76
1·50	7·178	12·92	12·92	15·07	20·10	16·51
1·75	8·374	15·073	15·07	17·59	23·45	19·26
2·00	9·57	17·226	17·23	20·10	26·80	22·01

ELASTIC GRIP ASSEMBLY EXPERIMENTS.

Nature of Surfaces.—The surface generated during the boring of the hollow element or the turning of the solid element is always a helical groove. The depth of the groove depends on the condition of the cutting edge and the feed of the tool. There are differences of opinion regarding the effect of the finish of the mating surfaces. Ideal conditions would appear to be afforded by smooth surfaces, which would make possible the greatest amount of bearing contact between the mating elements. Surfaces that are not too smooth, however, are recommended by some as providing the best protection against axial slip. Others suggest that the tops of the little ridges of such surfaces will be crushed during shrinkage, or sheared off in a force fit operation, and that the back pressure would be less than for elements with smooth surfaces. There is evidence to show that the degree of smoothness of the surfaces resulting from different machining operations has practically no effect on the coefficient of friction and the force necessary to bring about slip.

Good modern machine shop practice gives a degree of finish to mating surfaces, which is more or less free from tool ridges. Many such surfaces, however, have a pronounced out-of-straightness. It is suggested, therefore, that for elastic grip assemblies greater attention should be directed to the need of a higher degree of accuracy in the generation of the cylindrical mating surfaces, a condition more difficult to attain than a high surface finish. This would be facilitated by carrying out the final metal removal operation by grinding.

EFFECT OF LUBRICANT ON PRESSING-ON LOAD.

Workshop experience of the influence of a lubricant in preventing the mating surfaces of a force fit assembly from being scored or destroyed in making or breaking the fit, together with the evidence presented by R. M. Deeley, M.I. Mech. E., that the static coefficient of friction between the surfaces of different metals when lubricated depends upon the oiliness of the lubricant, suggested that in a force fit assembly the lubricant employed might have an appreciable influence on the pressing-on load. It was therefore decided to carry out tests on force fit assemblies, with some of the earlier vegetable and animal oils used as lubricants by the engineer, together with the later types of mineral and blended oils.

Tests to Investigate Effect of Lubricant.—Six tests were carried out with the same pin and collar having mating dimensions of 1·5038in. and 1·5030in. respectively, giving a difference in the free diameters of the mating elements of 0·8 thousandths of an inch. It can be shown that a force fit allowance of this order will induce a radial pressure intensity at the mating surfaces of 2·7 tons per square inch and a hoop stress intensity at the bore layer of 4·51 tons per square inch.

Test 1.—Elements assembled and dismantled with film of Bayonne oil on mating surfaces.

Test 2.—Elements assembled and dismantled with film of sperm oil on mating surfaces.

Test 3.—Elements assembled and dismantled with film of "Texaco" motor oil (heavy) on mating surfaces.

Test 4.—Elements assembled and dismantled with film of rape oil on mating surfaces.

Test 5.—Elements assembled and dismantled with film of graphite and engine bearing oil on mating surfaces.

Test 6.—Elements assembled and dismantled with film of cutting lubricant on mating surfaces.

The lubricant used in test 6 was an emulsion, suitable for general lathe work, made by mixing a cutting compound with water. Cutting oils and cutting compounds are used in metal machining operations not only to dissipate the heat generated and wash away the cuttings, but also to give a smooth finish and prevent rusting. The dimensions of the mating surfaces were measured before and after each test and these showed no signs of change. This is an essential condition, of course, to any successful investigation of the influence of the lubricant on the force fit tonnage. It was made possible by the use of elements having good mating surfaces and a relatively small force fit allowance. It is surprising that after assembling the elements six times there was no evidence of a tendency for the bore dimensions to become bigger or the pin dimensions to become smaller. A critical examination of the mating surfaces gave no evidence of improved bearing contact, a condition which would have influenced the pressure necessary to make the assembly.

Load diagrams on a base of bore length are given in Fig. 1 and indicate clearly the remarkable influence of the lubricant on the force necessary to make an assembly of the elements. The values range from 5·1 tons with rape oil as a lubricant to 13·55 tons with Bayonne oil. This represents an increase of 166 per cent. in the pressing-on load due to a difference in the nature of the lubricant.

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* The Institution of Mechanical Engineers. Read in Manchester on Thursday, December 7th.—Abridged.

† "Specification for Standard 12-ton Mineral Wagon," Railway Clearing House, April, 1923.

The coefficient of friction for each assembly was obtained by the equation

$$F = \mu \, p_r \, . \, 2\pi r \, . \, l \quad . \quad . \quad . \quad . \quad . \quad (2)$$

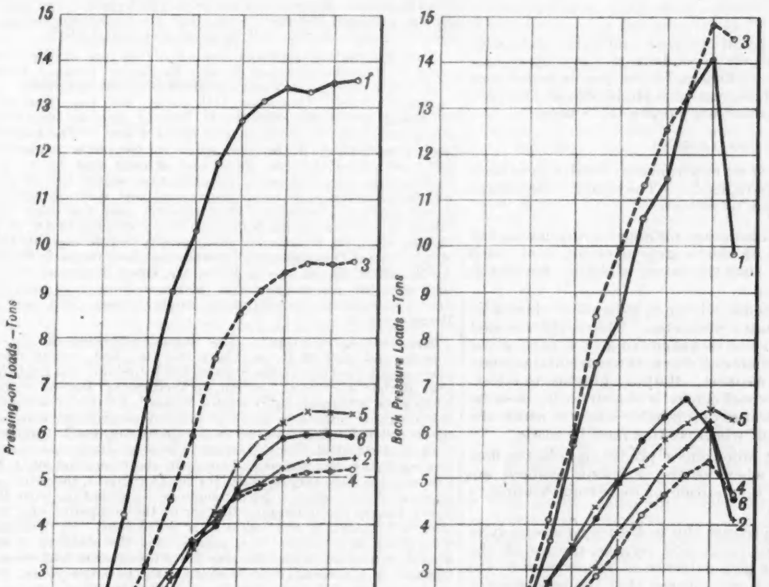
where F is the maximum pressing-on tonnage, l the length of the hollow element, and μ the coefficient of friction. The values obtained by this method of approach to boundary lubrication, given in Table III., are of a very high order and greatly in excess of those obtained by the Deeley machine using the same lubricants but different mating materials. It was found, however, that the ratios of the maximum load obtained with the various lubricants to the maximum load obtained with rape oil were of the same order as the ratios of the coefficients of friction obtained by the Deeley machine.

TABLE III.

Description of lubricant.	Force fit.			Deeley Machine.*					
	Maximum pressing-on tonnage.	Mild steel on mild steel.		Mild steel on cast iron.		Mild steel on Lead bronze.		Cast iron on cast iron.	
		μ	Ratio of pressing loads.	μ	Ratio of friction coeffs.	μ	Ratio of friction coeffs.	μ	Ratio of friction coeffs.
Bayonne oil..	13·55	0·852	2·657	0·213	1·79	0·234	1·721	0·236	2·458
Sperm oil	5·35	0·336	1·049	0·127	1·067	0·180	1·32	0·122	1·271
"Texaco" oil	9·60	0·604	1·882	—	—	—	—	0·186	1·938
Rape oil ..	5·10	0·321	—	0·119	—	0·136	—	0·096	—
Graphite and engine bearing oil	6·40	0·402	1·255	—	—	—	—	—	—
Cutting lubricant	5·94	0·374	1·165	—	—	—	—	—	—

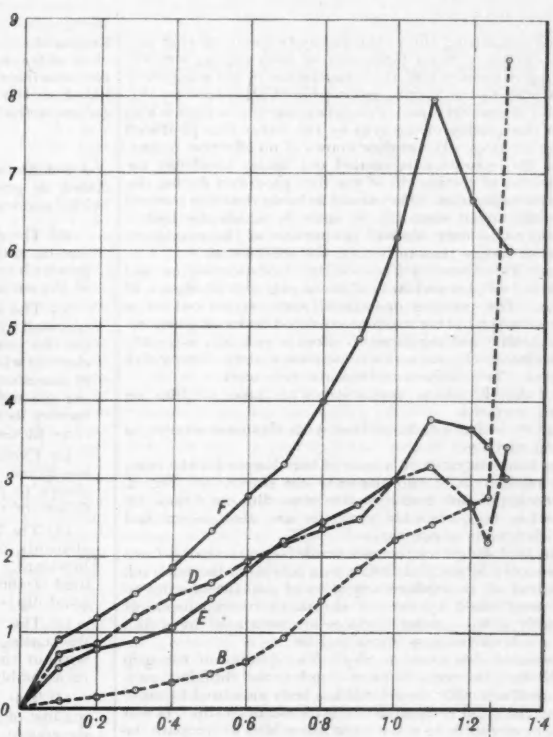
* *Jl.* Roy Tech. College, Glasgow, 1931, Vol. II., page 495.

In no case was an assembly made by a gradual slipping of the mating elements. The load gradually rose until slip took place, when there was a sudden fall in the oil pressure. This gradually rose again until a further slip and another drop in the oil pressure occurred. With those lubricants having a pronounced oiliness the slips took place without any noise until the assembly was half complete, after which slipping was accompanied by a light bumping on the sudden fall in pressure, which became more pronounced towards the completion of the fit. Periodic slips of much greater magnitude and accompanied by heavy bumping were noticed throughout the complete assembly of the elements when a lubricant not having an oiliness property was employed.



Test 1.—Bayonne oil.
Test 2.—Sperm oil.
Test 3.—"Texaco" motor oil (heavy).
Test 4.—Rape oil.
Test 5.—Graphite and engine bearing oil.
Test 6.—Cutting lubricant.

FIG. 1—LOAD DIAGRAMS FOR TESTS ON EFFECT OF LUBRICANT



Test F.—Force fit assembly. Bayonne oil film on mating surfaces.
Test E.—Force fit assembly. Rape oil film on mating surfaces.
Test D.—Expansion fit assembly. Rape oil film on mating surface of hollow element.
Test B.—Shrink fit assembly. Rape oil film on mating surface of solid element.

FIG. 2—LOAD DIAGRAMS FOR FORCE FIT ASSEMBLY TESTS

It was thought that the "skin" or thin layer of grease that tends to gather on the surface of an element during or after machining operations might in some way influence the effect of the lubricant in an assembly process. After completing the back pressure test in which the cutting compound was used as a lubricant, the surfaces of the pin and collar were wiped only with a clean cloth and then reassembled with rape oil as the lubricant. But the closeness of the readings obtained with these two lubricants and perfectly clean surfaces prevented any definite conclusions being reached. It was therefore decided to use two lubricants giving a high and a low load respectively with perfectly clean surfaces, and Bayonne oil and rape oil were selected as providing the best means of analysing this "skin" effect.

Five tests were carried out with the same pin and collar having a force fit allowance of 0·6 thousandth of an inch. From them it would appear that the "skin" or invisible primary film which may have been formed on the mating elements which were reassembled after having been treated with a clean cloth only, had no effect on the characteristic influence of the lubricant on the force fit load.

EFFECT OF ASSEMBLY METHOD ON THE QUALITY OF GRIP.

Shrink Fit Assembly Tests.—Experiments were carried out with two pins and two collars having a fit allowance of $^1/_{1000}$in. The collars were heated by a gas burner until a hole clearance was obtained, as measured by a gauge, which would just allow the collar to slip over the pin.

Test A.—The elements were assembled with the mating surfaces perfectly dry and free from film. The mating surface of the hollow element had just the slightest touch of colouring due to the heat applied.

A 20-ton Amsler testing machine failed to separate the elements and the back pressure test was completed by a 100-ton Avery horizontal testing machine. An initial load of 28·8 tons was required to produce slip, but a much greater axial load was required to maintain this condition. The clean mating assembly had allowed seizure to occur so strongly that relative motion pulled the surface particles of each solid out of position. The mating surfaces were torn to such a depth that no further use could be made of the elements. The quality of the grip established was such that the taper part of the solid element was shorn off, and left firmly embedded in the surface of the hollow element.

Test B.—The hollow element was prepared as in test A. The solid element or pin had a thin film of rape oil on the surface.

The back pressure test was carried out on the Amsler machine and a tonnage of 8·5 tons was recorded when slip occurred. This pressure dropped immediately to a value of 2·8 tons and then gradually fell off as the separation of the elements proceeded.

Very good surface conditions obtained after dismantling the elements. There was no sign of even the tiniest hairline scratch, but there was evidence that the mating surfaces had been separated by a lubricating film. The darkest colour in the bore surface could be lifted off with the lightest touch of the finger tip, revealing the bright steel mating surface underneath. It was decided, since the surfaces were in perfect condition and there was no change in the mating dimensions, to reassemble these elements under different conditions.

Test B_1.—The elements were reassembled with the mating surfaces perfectly dry and free from film, as in test A.

There was a slight creaking when the load applied reached 8·5 tons, but there was no measurable sign of slip within the load capacity of the Amsler machine. Slip took place when a load of 28·2 tons was reached on the 100-ton testing machine, and an increase in load was required, as in test A, to produce further slipping between the elements. The mating surfaces were very badly torn, large pieces of each mating element being pulled out of position. The grip was so well established that, as in test A, part of the solid element was shorn off during withdrawal and left firmly fixed to the surface of the hollow element.

These experiments demonstrate that a primary film may separate the elements in a shrink fit assembly, even when mated under a high radial pressure intensity. The results indicate that the presence of such a film will result in an enormous reduction in the axial resistance of the elements to slip. It is important to note that many builders of crank shafts make such adsorbed film conditions possible by lubricating the pin or journal in the hope of avoiding pre-seizure of the elements on assembly.

Assembly by Expansion Fit.—By this method the solid element is cooled to an extremely low temperature by immersing it in a refrigerant. This brings about a reduction in the diameter which will allow of it being slipped easily into the hole of the hollow element. The solid element, in returning to normal temperature conditions, expands, and the elastic strains and stresses induced in the elements result in an effective grip being established. Liquid oxygen, whose boiling point is at the extremely low temperature of −190 deg. Cent. (−310 deg. Fah.), was used as a cooling agent. The amount of contraction possible, which sets a limit to the maximum possible fit allowance by this method of assembly, is determined by the temperature at which the cooling agent evaporates. The solid element should just be a push fit when fully cooled. Although the shape of the part may influence the time necessary to bring about the lowering of the temperature, the liquid requirements are determined by the material and weight of the part immersed. These requirements can be reduced if the refrigerating capacity of the vapour which comes off the oxygen as it evaporates is usefully employed in pre-cooling the parts before immersion.

Expansion Fit Assembly Tests.—Experiments were carried out with two pins and two collars, having a fit allowance of $^1/_{1000}$in. The solid elements were cooled by liquid oxygen to a temperature of approximately −310 deg. Fah., which allowed of the pin in each case being easily slipped into the hole of the collar.

Test C.—The elements were assembled with the mating surfaces perfectly dry and free from film. The pin, after removal from the refrigerant, was rubbed hurriedly with a clean cloth before making the assembly.

The back pressure test was carried out on the Amsler machine, and a load of 4·35 tons was recorded when slip occurred. This pressure rose to a maximum of 5·05 tons, and an average pressure of a little over 4 tons was required to maintain a condition of slip over the first half of the operation. The mating surfaces were in perfect condition. A few extremely fine hair lines could be seen, but not felt, on the bore surface, and these, if rubbed lightly with the finger tips, could be removed.

Test D.—The solid element was prepared as in test C. The hollow element had a thin film of rape oil on the bore surface.

The back pressure test gave a load of 3·425 tons when slip occurred. The pressure then dropped suddenly, rising afterwards to a value of 3·15 tons, after which there was a gradual drop.

The surface conditions were excellent after breaking the fit. There were a few fine hair lines on the mating surface of the hollow element, similar in character to those described in test C. It was decided, since there was no change in the mating dimensions, to reassemble these elements under different conditions.

Test D_1.—The elements were re-assembled by shrinkage with the mating surfaces perfectly dry and free from film.

Slip took place when a load of 20·86 tons was reached on the 100-ton testing machine. A much greater axial thrust was required, however, to effect further separation of the elements. Seizure at the points of contact was so strong that slip caused the surface particles of each element to be pulled out of position and these were rolled and dragged during further separation of the elements so that the mating surfaces were very badly torn.

The low tonnage obtained in test C, together with the excellent condition of the mating surfaces after dismantling, would suggest that the solid elements were separated by a very thin film and failed to make actual contact. Although an endeavour was made to have the surfaces perfectly dry and free from film at the instant at which the assembly took place, there can be no doubt but that a water film formed on the pin by frosting during the expansion period. This film would act as a lubricant and the friction during slip of the elements would be that due to two primary water films, one on each mating surface. As already pointed out, the temperature of the refrigerant sets a limit to the maximum possible fit allowance by this method of assembly, and it would appear that a limit is also set to the quality of the grip by the water film produced during frosting. The author knows of no effective means, unless the operation is carried out under ideal dry air conditions, of getting rid of the film produced during the period of expansion. This would indicate that this method is limited to an assembly of units in which the hollow element takes only a small proportion of the maximum thrust or torque transmitted by the solid element.

TABLE IV.

Test.	Assembly method.	Surface condition.	Torsional slip, spring balance reading.	Axial slip, tons.	Coefficient of friction.	
					Torsional.	Axial.
G	Force fit	Rape oil film	90 lb. at first slip .. 95 lb. at second slip	2·6	0·3	0·263
H	Shrink fit	Rape oil film	100 lb. at first slip .. 80 lb. at second slip	2·6	0·29	0·263
I	Shrink fit	Perfectly dry and free from film	260 lb. at first slip .. 260 lb. at second slip	12·8 (slight slip of pendulum) 20·8	0·906	1·295

Force Fit Assembly Tests.—Experiments were carried out with two pins and two collars having a fit allowance of $^1/_{1000}$in. The pressing operations were carried out on a 20-ton Amsler testing machine operated under oil pressure. The machine was regulated to effect a complete assembly or dismantle the elements in approximately twenty-five minutes. Two different lubricants were used.

Test E.—Elements assembled with rape oil film on mating surfaces.

Test F.—Elements assembled with Bayonne oil film on mating surfaces.

The load diagrams on a base of bore length for the complete separation of the elements are shown in Fig. 2. The back pressure loads for the same film conditions by the other two assembly methods are also shown and provide a basis of comparison.

The load diagrams secured would suggest that a force fit assembly of elements using as a lubricant Bayonne oil, a mineral oil, may afford a quality of grip far superior to that established by even a shrink fit or expansion fit assembly if the mating surfaces are separated by a film with a distinct oiliness characteristic.

Torsional Resistance to Slip.—The quality of the grip established between elements under the different conditions of assembly considered has been measured by comparing the axial resistance of the elements to slip. It was thought advisable to make a few assemblies to compare the grip by the torsional resistance of the elements to slip. It was hoped that this would also provide sufficient data for comparing the axial and torsional coefficients of friction for the different assembly conditions. The solid element, in this case, was supported horizontally between centres and firmly fixed at one end. The hollow element had two notches cut on the outer surface, and the lever arrangement was made to engage with the notches cut in the hollow element without transmitting any appreciable load to the outer surface. The pull at the free end was applied by pulley blocks and the value, when slip occurred, was accurately determined by the sudden drop in the spring balance reading. Clean mating surface conditions were obtained in each case by the methods described in previous tests.

Tests to Investigate Torsional Slip.—Three tests were carried out with the same pin and collar having a fit allowance of 0·5 thousandth inch. A fit allowance of this order will induce a radial pressure intensity at the mating surfaces of 1·68 tons per square inch.

Test G.—The force fit assembly was made with a rape oil film on the mating surfaces.

The pull was applied at 60in. from the axis of rotation and initial slip took place when a pull of 90 lb. was recorded on the spring balance. The pull was increased to 95 lb. before further slip occurred.

The back pressure test was carried out on the Amsler machine and a load of 2·6 tons was recorded when slip occurred.

There was no change in the mating dimensions, after separation, and the surfaces were found to be in a very good condition. This allowed of a further assembly of the elements.

Test H.—For the shrink fit assembly the elements were re-assembled with a rape oil film on the mating surface of the solid element.

Initial slip took place when a pull of 100 lb. was recorded on the spring balance. Further slip was possible, however, with a pull of 80 lb.

A back pressure of 2·6 tons was required to induce initial slip.

No change was found in the mating dimensions after separation, but there were a few thin grooves along the surface of the hollow element. The solid element had still a very good mating surface. An examination of the hollow element indicated that the surface, although bearing a few score lines, would allow a further assembly to be successfully made.

Test I.—The elements were again re-assembled as a shrink fit with the mating surfaces perfectly dry and free from film.

Initial slip took place when a pull of 260 lb. was recorded on the spring balance.

The back pressure test was carried out on the Amsler machine, and although a slight slip in the pendulum was noticed at 12·8 tons there was no measurable slip between the elements within the capacity of the machine. The back pressure test was completed on the 100-ton testing machine and axial slip took place at a load of 20·8 tons. The mating surfaces were very badly torn, large pieces of each mating element being pulled out of position.

The torque that an assembly fit is capable of transmitting is based by designers on an assumed coefficient of friction. This value, unfortunately, varies over a wide range and may lead, if a low or "safe" coefficient is assumed, to excessive fit allowances and possible failure.

The values given in Table IV. confirm a previous finding that the quality of the grip, and hence the coefficient of friction, is greatly dependent on a mating surface film condition. The coefficient of friction in test I was based on the load which caused a slight slip in the pendulum of the testing machine, namely, 12·8 tons.

CONCLUSIONS.

A few findings based on experimental results have been stated in previous paragraphs. The main conclusions, briefly summarised, are as follows :—

(*a*) The degree of accuracy obtained in machining the mating surfaces of an elastic grip assembly is of much greater importance than the nature of the machine finish of the surfaces.

(*b*) The materials used in such assemblies should be specified by their elastic properties. The test pieces used for this purpose should be taken from that part of the element where the material, due to the particular method of manufacture, is weakest. Railway practice in selecting the web of a wheel centre is shown to be unsatisfactory as failing to provide reliable data on which the force fit assembly of wheel centres may be made.

(*c*) Excessive fit allowances producing plastic flow conditions in the wheel centre or hollow element are shown to produce a condition of overstrain leading to failure of the grip.

(*d*) The load to produce slip in a force fit assembly of elements is greatly influenced by the nature of the lubricant. Results give evidence of an increase in the load of 166 per cent. and suggest that the resistance to axial slip is not altogether a question of the fit allowance.

(*e*) The "skin" or film, if a fluid, which may gather on the mating surfaces before assembly, may be removed without the use of solvents, and the resistance to slip on assembly is controlled by the nature of the lubricant.

(*f*) The assembly method may not determine the quality of the grip. Results show that this is greatly dependent on the surface film condition which may separate the mating surfaces after assembly. Such surface films, although more likely to be present under certain conditions of assembly than in others, may be equally operative under all three.

(*g*) A successful shrinkage assembly may be established with a fit allowance producing stresses well within the elastic range of the material, if the mating surfaces are perfectly dry and free from film.

(*h*) There is no evidence that the "torsional coefficient of friction is greatly in excess of the axial coefficient of friction" sometimes quoted.

The author feels that a great deal of experimental work remains to be done on the effect of surface films on the grip in an elastic assembly of elements. It remains to be determined whether a period of time would have any effect on the great variation in the axial resistance to slip produced by different lubricants in force fit assemblies. In the tests described the elements were dismantled immediately after the assembly was made.

Experiments are still required to determine whether the nature of the lubricant would be as effective if the assembly unit was subjected to shock conditions, as represented by end blows or sudden torque impulse. Skin effect could be further examined by a consideration of the effect on the load when elements with perfectly clean surfaces and various lubricants are re-assembled, the mating surfaces having been wiped thoroughly with a clean cloth.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

GREENWOOD AND BATLEY, Ltd., Leeds, have recently received an order from the Fife Coal Company, Ltd., for an 8-ton "Greenbat" mining locomotive. This is the third engine of this type purchased by the company.

SIR W. G. ARMSTRONG WHITWORTH AND CO. (ENGINEERS), Ltd., have been given an order by the G.I.P. Railway for a Diesel-electric railcar for use on the Central Provinces Railway. It will be equipped with a 122/140 B.H.P. engine.

HARLAND AND WOLFF, Ltd., have been entrusted with the building of a target-towing tug for the War Office. It will be about 112ft. in length, and will be propelled by oil engines of the Harland-B. and W. type, and will be laid down at Govan, whilst the machinery will be constructed at the builders' Finnieston Diesel Engine Works, Glasgow.

C. A. PARSONS AND CO., Ltd., of Newcastle-on-Tyne, have received from the East Rand Proprietary Mines, Ltd., of South Africa, an order for a turbo-alternator of 20,000 kW capacity, complete with condensing plant. The turbine will develop its power in a single cylinder exhausting into a condenser of the inverted type. The alternator is of special interest, for it will have a two-core concentric winding and will generate current at the unusually high pressure of 22,050 volts.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

PETER STUBS, Ltd., Warrington, have appointed Messrs. J. Penny and Son, Argyll Works, Alma-street, Smethwick, as their representatives for the sale of steels in the Birmingham area.

ANDREW CARNEGIE RESEARCH FUND.—The Council of the Iron and Steel Institute is prepared to make annually a limited number of grants from the Research Fund founded by the late Mr. Andrew Carnegie in aid of metallurgical research work. The object of the scheme is not to facilitate ordinary collegiate studies, but to enable students who have passed through a college curriculum or have been trained in industrial establishments to conduct researches on problems of practical and scientific importance relating to the metallurgy of iron and steel and allied subjects. Candidates, who must be under thirty-five years of age, must apply before the end of next February on a special form to be obtained from the Secretary of the Iron and Steel Institute. The value of the grant will depend on the nature of the proposed research work, but the maximum amount granted in any one year will, as a rule, not exceed £100.

THE ENGINEERS' GERMAN CIRCLE.—The last of the 1933 series of lectures arranged by the Engineers' German Circle took place at the Institution of Mechanical Engineers on Monday evening, December 11th, when Dr. Ing. Eberhard Westphal, of the Schichau Werft, Danzig, gave an illustrated lecture on "The Improvement of Ships' Plans." The lecturer dealt principally with the arrangement of the public rooms and cabin accommodation in ships, and showed that by careful re-planning a considerable simplification could be effected which made the ship more economical and safer in service. About forty-five members were present, and the chair was taken by Mr. W. Roylands Cooper, in the absence of Dr. S. J. Davies, who, on Wednesday last, gave a lecture on "Modern Motive Power Developments" before the sister Circle in Berlin. As Mr. H. P. Spratt was in Paris, Mr. Ernst Schneider kindly took over the secretarial duties for the evening. An informal dinner was afterwards held at the Anglo-German Club, Carlton House-terrace.

THE HOUSE OF LISTER.—The annual gathering of agents, friends, and staff of R. A. Lister and Co., Ltd., which takes place about the time of the Smithfield Club Show, was held this year at the Café Royal, London, on Wednesday, December 6th, when some 500 guests sat down for dinner. A letter of welcome, the menu, a timetable, and the musical programme wrapped up in roll form and inserted in a napkin ring made from the teak timbers of H.M.S. "Terrible," was awaiting each guest. During dinner, Mr. Robert B. Lister, the chairman, and Mr. J. H. Thomas, the Secretary of State for the Dominions, the principal guest of the evening, held a telephone conversation with Mr. Percy Lister, the managing director of the company, who was then in Chicago, in the course of a world tour. Mr. Thomas, who spoke in a serious vein, commended the stability of the British constitution, and the way the whole nation had worked together to overcome the difficulties of the past two years. He said that Great Britain was the only nation which was in a position to say that the worst was over, and he was proud that this Christmas would find more than 800,000 more unemployed at work. The toast proposed by Mr. Thomas was that of "British Industry," and Mr. R. B. Lister responded, after which the usual toast of "The House of Lister" was given by Mr. H. F. Pash and acknowledged by Mr. Sidney Howard, the principal actor at the Aldwych Theatre. During the evening a musical programme was given by the new Lister military band. After dinner the guests left the Café Royal in private coaches and proceeded to the Aldwych Theatre.

THE BRITISH OXYGEN COMPANY, LTD.—A pleasing function took place at the Café Royal on Friday last, December 8th, when some 370 members of the staff from nearly forty of the various works of the B.O.C. and allied companies throughout the country, gathered at the annual dinner of the London staff of the British Oxygen Company, Ltd. At the dinner a presentation was made to Mr. K. S. Murray, to mark his retirement at the end of 1933 from the chairmanship and managing directorship of the company. The presentation took the form of an album containing an illuminated address followed by the signatures of over 2500 directors, members of the staff, and workpeople of the main and allied companies in Great Britain, together with a silver cigar box, suitably inscribed, and filled. It is a fitting tribute to Mr. Murray that the illuminated address is followed by the signatures, done in facsimile, of every man and woman at present in the company's employ in over forty works and offices throughout the country. After meeting the expense of the personal gift to Mr. Murray, a sum of about £300 remained from the funds collected, and by Mr. Murray's express desire this will be used in some way which shall be of benefit to the staff and workpeople of the company. The presentation was made by Mr. H. J. Chadd, the company's district manager of the Midland and South-Western areas, who joined the original Brins Oxygen Company in Westminster in 1886, about the same time as Mr. Murray, and by Mr. Charles Sharp, who is Mr. Murray's oldest colleague on the board of directors of the company. The toast of "The British Oxygen Company" was proposed by Mr. Murray, and replied to by Mr. J. L. Buchanan, while Mr. Frank Payne proposed the toast of "The Chairman." A feature of the evening was the presence of the pipers of the 1st Battalion of the Scots Guards, who piped Mr. Murray to his place, and took part in providing the music for dancing which followed the dinner. The evening was a most enjoyable one in every respect.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Pig Iron Market.

Seasonal influences have affected this market and trading has been quieter during the past week. Some heavy contracts were placed recently, and although the specifications against these are reaching the producers on a satisfactory scale, current business seems to have relapsed into hand-to-mouth buying of small quantities to supplement supplies already arranged for. This is probably a relief to some makers on the North-East Coast, who were finding the pressure of consumers for both near and forward delivery rather inconvenient, as most of the stocks were sold forward and the demand was in excess of the production. It is understood that directly satisfactory supplies of coke can be assured the production of Cleveland iron will be increased. There is no change in prices, No. 1 being quoted at 65s. and No. 3 at 62s. 6d., d/d consumers' works, with an additional 2s. per ton to other consumers in the North-Eastern area. The price to Scottish consumers is based on 65s. 3d. for No. 3, d/d Glasgow, and 62s. 3d., d/d Falkirk. Conditions in the hematite market also are becoming difficult, as although there are still fair stocks at the furnaces, the makers state that a good proportion of these have been sold. The situation is further complicated by the fact that Pease and Partners, Ltd., are to close down two of their blast-furnaces, producing hematite, for repairs, which, it is understood, will take about two months to complete. Most makers are reluctant to accept important forward commitments and point out that in all probability the cost of ore and coke will be higher in the New Year, which may lead to an advance in the price of hematite iron. The Midland makers are in a satisfactory position, since their order books are well filled. The demand has been rather lighter of late, but as the makers regard the price situation as uncertain they are well content to rest for the time being on the orders in hand supplemented by a fair amount of prompt business. There has been no change in the basis prices of Midland irons, which are 62s. 6d. for Northamptonshire and 66s. for Derbyshire No. 3 foundry. The total production of pig iron in this country in November reached 374,900 tons compared with 373,300 tons in October. This was the highest output attained by the British industry this year. The lowest being the February figure of 270,800 tons.

Scotland and Lancashire.

During the last few weeks the situation in the Scottish steel industry has undergone a rapid change for the better owing to the contracts which have been booked for ships, locomotives, wagons, and tubes, and export orders for constructional work abroad. The steel works, however, will not benefit from these orders immediately, and in the meantime operations at some of the mills have declined. An indication, however, of the busy conditions which rule at the light castings department is the decision to re-start the Castle Laurie Foundry in the Falkirk district, which has been closed down for some time. Re-rollers in Scotland are not so well employed as their competitors in England, but they continue to hold their quotation for small bars at £7 5s. for home and £6 5s. for export. The sheet industry is moderately occupied, but export business is difficult, as competition in this department has increased during the past few weeks on the depreciated dollar exchange. The home demand, however, has been steady. Progress at the Lancashire finished steel works continues steady and the new railway orders for wagons and locomotives have already had a beneficial effect upon the position. Business in structural steel is irregular, and whilst some works producing this material are actively engaged, others are anxiously seeking orders to take the place of completed contracts. The demand for small bars shows no signs of relaxing and business in bright-drawn steel, alloys and special steels is well maintained. Steady conditions prevail at Barrow and Workington. The demand for baling hoops, spring steel, and small sections is sufficient to keep the mills busy for some time, and it is estimated that it will be possible to keep the works running at a good rate of operation for several months.

The Midlands and South Wales.

On the whole the situation in the Midland iron and steel markets is satisfactory, and although operations at the finishing mills are irregular, the majority of the works are well provided with orders and some are working at high pressure. A sustained demand for steel strip is a feature of the market, and although fair quantities of Continental material are being imported, practically all the home strip mills are busy and in some cases are behindhand in deliveries. The strength of the demand is indicated by an advance of 10s. per ton in the price of cold-rolled steel strip, which has brought the quotation for close annealed to £20 and for unannealed to £16. The re-rolling mills are well supplied with orders and most of them quote £7 10s. d/d for small bars, although with a good specification it would still be possible to place business at £7 5s. The tonnage of orders going to the Continent has increased of late, but this is scarcely to be wondered at, since the Continental price for merchant bars delivered and duty paid is held at the comparatively low figure of £6 10s. 6d. The steel works are not receiving so much business in bars as are the re-rollers, but the amount of work they have in hand is increasing. The steel makers' quotations range from £7 15s. to £8 10s. Business in joists has been only moderately good, but comparatively small quantities are going to the Continent, as the English steel makers' rebate scheme is very effective in this department. The quieter conditions in the South Wales tin-plate trade have not so far affected production at the steel works. Business from the engineering departments has been rather better, and the demand from the ship repairing yards has also helped to give the market an appearance of activity.

The North-East Coast and Yorkshire.

The activity in the finished steel department of the market has been well maintained, but the usual seasonal influences are beginning to affect the placing of contracts. This is largely the result of the slowing up which takes place before the end-of-the-year stocktaking in most departments of the trade. It is a long time, however, since business has been maintained at such a high rate so late in the season. On the North-East Coast the output of the steel furnaces and the rolling mills has been considerably increased of late and shipbuilding orders placed in this district are expected to provide work for the plate and section mills early into the New Year. This is the more satisfactory, as although production in this district has been on a good scale for some months, the absence of any important shipbuilding orders has been the weak spot in the situation. The departments turning out steel for bridge building are well employed, and on the whole the industry in this district will enter 1934 with better prospects than for years past. Little sign is noticeable in the Sheffield district of the usual seasonal decline. Notwithstanding the heavy demand which has existed for some time for hot and cold-rolled strip and stainless steel sheets, business in this department seems to be expanding. There is also an active request for alloy steels, although in this section the demand is not up to the level of a few weeks ago. A steady increase in business in re-rolled material continues and is one of the features of the position in this district. Latterly there have also been some inquiries for railway material on export account, which, it is hoped, will result in orders.

Current Business.

An order for a 20,000-ton liner has been placed with Vickers-Armstrong, Ltd., at Barrow by the Orient Steam Navigation Company, and orders for two tugs have been awarded to Harland and Wolff, of Govan, by the South African Railways and Harbours Administration. It is estimated that the shipbuilding orders placed on the Clyde in November totalled in value £1,000,000. A contract has been obtained by Sir William Arrol and Co., Ltd., for a swing bridge over the Clyde and Forth Canal, valued at £10,000. The Cleveland Bridge Building and Engineering Company, Ltd., of Darlington, has commenced work on the bridge over the Forth at Kincardine, which, it is estimated, will involve the use of about 4000 tons of steel. The recent improvement in the engineering industry is indicated by a circular issued by Glenfield and Kennedy, Ltd., of Kilmarnock, which states that during the past month they have secured substantial export orders from twenty different countries. The enterprise shown by manufacturers in meeting the requirements of the market is instanced by the Stanton Ironworks Company, Ltd., which has added to its range of Stanton Delavaud spun iron pipes a 3in. diameter spun iron pipe, ¼in. thick, weighing 1 cwt. per 12ft. length. This is sold at a price of 2s. 1½d. per yard, f.o.t. manufacturers' works. Although it conforms to the British Standard Specification and is tested to 200 lb. per square inch, the new pipe is not intended to replace the present thicker 3in. diameter spun iron pipe. The manufacturers anticipate, however, that it will be adopted by many buyers who prefer cast iron pipes to those of other materials. The Department of Overseas Trade announces that the following contracts are open for tender :—New Zealand : Wellington Post and Telegraph Department, 50 miles of tinned copper V.I.R. wire (Wellington, February 13th) ; 75 tons of hard-drawn copper wire (Wellington, February 5th) ; Trinidad : a local architect requires quotations for structural steel and sheet metal work for a new Masonic building ; Egypt : Ministry of Finance, Survey Department, new or second-hand rails up to 3000 tons, totalling 2500 tons of light section and 500 tons of heavy section rails, in any quantities (Egypt, January 20th) ; Ministry of Public Works, steel plates ranging from ⅛in. to ⅜in. thick, 7ft. to 12ft. long and 3½ft. to 5ft. wide;; mild steel T.S. flats and angles, and wagon leaf spring steel (Cairo, January 8th).

The Tin Market.

Interest has been centred this week upon the meeting of the International Tin Committee, which took place in Paris. Following the meeting the text of the agreement governing the International tin control arrangements was issued. The scheme was renewed from October 27th last, and many details were published at the time. The gradual extension of the control of the metal is an interesting feature of the position, and it was announced that the French Government had become a party to the scheme. Apparently, discussions are also taking place with China, South Africa, Burma, and the Belgian Congo, with a view to bringing these tin-producing countries into the control arrangement. The Committee agreed that the export quota from January 1st should be fixed at 40 per cent. of the standard tonnage. The interesting statement was issued that the stocks remaining in the hands of the International Pool amounted at the end of November to 8000 tons. At one time the Pool held stocks of over 21,000 tons of tin, but it was thought that a greater proportion of this had been disposed of than appears to be the case. Although on the whole the arrangement may be regarded as satisfactory, the market was not greatly affected. Prices showed a tendency to advance, but buying, which it was thought might develop, has been only on a moderate scale. America has shown comparatively little interest, and purchases by the Continent, beyond some orders from Russia, have been limited to small quantities. The statistical position is strong, and it is expected that the figures at the end of December will show a further decrease in the visible supply, and that the poor American deliveries in November will be more than made up. It is suggested that the 3350 tons given as the American deliveries last month did not really represent the situation, and that considerable inroads were made into the stocks, so that the position was actually better than was disclosed by the statistics. The stocks in this country continue to be drawn upon and this process is likely to continue for a time.

Copper.

Conditions in the electrolytic copper market have been largely governed by the fluctuations in the American exchange, but of late there has been a rather better tone noticeable, and consumers have shown a greater readiness to buy. The volume of business, judged by normal standards, has been small, but there has certainly been an improvement upon the past few weeks. and this is the more encouraging as it has taken place towards the end of the year, when there is a general reluctance to add to the stocks, in view of the customary stocktaking. The American domestic price has strengthened slightly to 7·75 c. to 8 c. The export quotation has fluctuated somewhat, but most business has been done on the basis of £35 10s. to £35 15s. c.i.f. Europe. Apparently, the copper producers derived confidence from the improvement, slight as it was, and have shown less willingness to follow the market down. In fact, on occasion they have withdrawn their offers when the price showed a tendency to weaken. To some extent the brighter conditions may be due to efforts on the part of dealers to secure shipments before the increased Atlantic freight rates come into operation on January 1st. The most active market seems to have been Germany, but the difficulty of securing payment, owing to exchange restrictions, has held up a certain amount of business. The decrease in the price margin between electrolytic and standard copper to about £3 has led to some buying of the latter by merchants. When the whole position is summed up, however, it has to be admitted that the volume of business in this metal is still on a disappointing scale. Business in the standard market has been steady, although there has been a certain amount of bear covering. The stocks of standard copper, however, are not heavy, and it has not always been easy to obtain the copper required, as warrants are strongly held. In these circumstances, with the market rather more " bear " than " bull," a backwardation has developed of from 2s. 6d. to 3s. 9d. Nervousness has been expressed lest this should be considerably increased. There seems, however, little likelihood of the market developing in this way, since for the time being it appears to be under the control of strong interests who would not favour such a position.

Lead.

Little change has occurred in the conditions which have prevailed in this market for some time. The chief characteristic has been the steadiness of the market and the limited movements of prices. Producers can scarcely be satisfied with the present level of values, and although the Mt. Isa strike still continues, the producing interests can probably afford to regard the situation without anxiety, since stocks are heavy and the present supplies are quite sufficient to meet the requirements of the market. In fact, at current prices there has been some talk lately of mines in other parts of the world closing down or considerably curtailing their output. The demand from consumers has become rather irregular of late, and some good orders have been placed by the chemical engineers. This industry is probably the largest consumer of lead pipes, and normally takes about 20,000 tons per annum. There has also been a fair demand from the building trades, but not upon the scale of recent months. This decline, however, is only to be expected, in view of the advanced season of the year. There is a good demand for lead from the battery makers, but business with the cable industries has become distinctly poor. Prices in the United States have receded, and this may be regarded as an indication that conditions in that market cannot have been much improved by the recovery programme, as the producers are protected from competition by a tariff of 2½c. on imported lead. The stocks in America are estimated at about 175,000 tons, which is almost the same as at the beginning of the year, although in the interval they touched a considerably higher figure.

Spelter.

At the end of last week this market developed a slightly firmer tone, but this was not maintained, and prices again developed an easier appearance. Consumption has not been upon a satisfactory scale for some time. Probably the brass trades have been the largest consumers, whilst the galvanisers, who have experienced quiet conditions, have been unable to give much support to the spelter market. Considerable interest was taken in the meeting of the Continental Spelter Cartel, which took place on December 11th. It had been anticipated that a curtailment of production would be decided upon to bring it more into line with the demand. It was also understood that a proposal would be discussed for making the penalties for over-production by members of the Cartel much heavier than at present. Apparently, these measures did not receive the necessary support, and it was decided to leave the present arrangements unchanged until July 31st, 1934. The somewhat ineffective result of the meeting did not influence the market a great deal, although prices dropped slightly. Fresh arrivals of metal are expected from Germany this month, and this has had a rather adverse effect upon the position, although, of course, the metal itself will go into bonded warehouse. The American statistics give the stocks at the end of November as 101,000 tons, an increase of 5860 tons over the October total. The production was 32,900 tons, compared with 35,100 tons in October, whilst the deliveries dropped to 27,000 tons, against 38,200 tons in the previous month.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	£ s. d.	£ s. d.
N.E. COAST—		
Hematite Mixed Nos. ..	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry ..	3 6 0	—
„ „ Forge ..	3 1 0	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto ..	3 7 6	—
No. 3 Foundry, ditto ..	3 5 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos. ..	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home.	Export.
	£ s. d.	£ s. d.
LANCS.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.) ..	12 0 0	—
Nut and Bolt Bars ..	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best..	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars ..	10 15 0	10 0 0

STEEL.

	Home.	Export.
LONDON AND THE SOUTH—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees..	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels..	8 15 0	7 12 6
Rounds, 3in. and up ..	9 10 0	8 7 6
„ under 3in. ..	6 17 6	—
Plates, ⅜in. (basis) ..	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ 3/16in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
NORTH-EAST COAST—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels..	8 12 6	7 12 6
Rounds, 3in. and up ..	9 7 6	8 7 6
„ under 3in. ..	7 0 0	6 10 0
Plates, ⅜in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in. ..	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees..	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels..	8 12 6	7 12 6
Rounds, 3in. and up ..	9 7 6	8 7 6
„ under 3in. ..	7 5 0	6 10 0
Plates, ⅜in. (basis) ..	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in. ..	8 5 0	7 12 6

STEEL (*continued*)

	Home.	Export.
GLASGOW AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees..	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels..	8 12 6	7 12 6
Rounds, 3in. and up ..	9 7 6	8 7 6
„ under 3in. ..	7 5 0	6 15 0
Plates, ⅜in. (basis) ..	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ 3/16in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees..	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels..	8 12 6	7 12 6
Rounds, 3in. and up ..	9 7 6	8 7 6
„ under 3in. ..	7 0 0	6 10 0
Plates, ⅜in. (basis) ..	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ 3/16in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

IRELAND—	BELFAST.	REST OF IRELAND.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees..	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels..	8 17 6	9 0 0
Rounds, 3in. and up ..	9 12 6	9 15 0
„ under 3in. ..	7 10 0	8 0 0
Plates, ⅜in. (basis) ..	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ 3/16in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G to 13-G., f.o.r. ..	8 15 0	8 15 0
14-G to 20-G., d/d ..	10 0 0	9 0 0
21-G to 24-G., d/d ..	10 5 0	9 5 0
25-G to 27-G., d/d ..	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots ..	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/6 to 16/9.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)..	6 17 6
„ Hard (0·61% to 0·85% C.) ..	7 7 6
„ „ (0·86% to 0·99% C.) ..	8 7 6
„ „ (1% C. and up)..	8 17 6
Soft (up to 25% C.), 500 tons and up..	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t. ..	8 10 0
„ Light, f.o.t...	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c. ..	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c. ..	£21 12 6	7/–
„ „ Specially Refined ..		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free ..	10½ per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c. ..	£11 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum..	5/6 per lb.	
„ Titanium (carbon free) ..	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, December 13th.

COPPER—		
Cash	£30 15 0 to £30 16 3	
Three months	£30 17 6 to £30 18 9	
Electrolytic	£33 10 0 to £34 10 0	
Best Selected Ingots, d/d Birmingham	£34 5 0	
Sheets, Hot Rolled	£60 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis) ..	9¾d.	9¾d.
„ Brazed (basis)	9¾d.	9¾d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	8¾d.	8¾d.
„ Brazed	10¾d.	10¾d.
TIN—		
Cash	£229 0 0 to £229 2 6	
Three months	£229 0 0 to £229 2 6	
LEAD:	£11 12 6 to £11 16 3	
SPELTER:	£14 16 3 to £15 2 6	
Aluminium Ingots (British).. ..	£100	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—Navigation Unscreened	12/9 to 13/–
„ Glasgow— Ell	13/– to 15/6
„ „ Splint	16/6
AYRSHIRE	
(f.o.b. Ports)—Steam	13/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	14/– to 14/6
Unscreened Navigation	12/3 to 13/–
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime..	14/– to 14/6
Secondary Steam	13/3 to 13/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke..	13/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/– to 14/3
„ Second..	12/9 to 13/–
„ Best Small	10/–
Unscreened	11/6 to 12/6
DURHAM—	
Best Gas..	14/8
Foundry Coke	17/– to 18/6

	Inland.	
SHEFFIELD—		
Best Hand-picked Branch ..	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds ..	17/6 to 19/6	—
Rough Slacks..	6/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/–
Ordinary Dry Large	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	20/– to 36/–
Furnace Coke	18/6 to 19/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles..	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm..	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon
Furnace Oil (0·950 gravity)..	3¼d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Craftsmanship.

A sign of the importance attached to a decentralisation of industry was afforded by the inauguration in Paris last week by the President of the Republic of a huge reinforced concrete and steel building covering 32,280 square feet, known as the Cité Artisanale Clémental, containing 430 workshops, with areas ranging from 130 to 860 square feet, and each supplied with water, gas, electricity for power and light, compressed air, central heating, and telephone. There is a spacious sales hall, as well as postal and despatch services, and everything to make the building self-contained. The Cité Artisanale lies in a district where small craftsmen have for generations crowded together in buildings with rooms fitted up as workshops, with machines driven from shafts taking power from an engine, usually installed in the basement. These men are expert mechanics who prefer to be independent, and the work done by them is of a high quality, and the cost is low because there are practically no overhead charges. Many of these insalubrious collective workshops are doomed to demolition, and the Cité Artisanale Clémental marks a new departure in providing men with workshops where they can carry on their trades under favourable conditions, and may become owners of the shops after paying rent for a certain number of years. It has another significance in showing what is being accomplished by the Confédération Générale de l'Artisanat Français in organising small craftsmen all over the country. Expert workers generally prefer to be their own masters rather than be wage earners in big factories. There are no recent figures of the number of workshops and factories in France, but those for 1921 gave a total of 1,433,000, comprising 958,251, with men working on their own account by themselves or with one assistant, 321,497 with two to five helpers, and 25,217 employing six to ten men. No one employing more than ten men is included in the category of master artisans. These small workshops, of course, cover every branch of industry, and the proportion of master mechanics and those engaged in metal working of all kinds is quite large. In view of the enormous preponderance of small producers, the Confédération Générale de l'Artisanat Français has definite views upon the part they will play in industrial reorganisation. The President, Monsieur Tailledet, believes that the restrictions imposed by foreign markets will seriously affect the situation of factories running on lines of mass production, and that more importance will consequently be given to the small artisan class. He affirms that about 80 per cent. of the production of small workshops in the Paris district and practically the whole of the production in the provinces consists of essentially French luxury goods for export. This dependence upon a foreign demand does not apply so much to the metal-working industry, except art metal goods and fittings. Seeing that more than a million master artisans are declared to be working mainly for export, and are consequently suffering from the restrictions imposed by foreign markets, there appears to be some ground for the fear of exporting industries that a continuance of the present trade policy may have the effect of throwing 2,000,000 men out of work. The idea of the Confédération Générale de l'Artisanat is to reverse a policy which is mainly guided by particular interests, and to organise the artisan community in a way to make it a power in the land and develop a movement for trade facilities in co-operation with similar artisan federations in other countries. In Germany the movement is said to be particularly strong. There is nothing subversive in the French programme. Instead of concentrating effort on big factories for the production of certain classes of goods, which, it is affirmed, can be produced more satisfactorily by individual skill than by mass methods, the object of the artisanal movement is to save skilled workmen from what is declared to be the servitude of the machine; to regard the machine as the servant of the man and not as a primary means of production in which the man loses his skill and individuality; to group master craftsmen for the sale of their goods direct to consumers and to promote the training of skilled workers from the constantly swelling ranks of young men who study for engineering and other professional degrees with little prospect of ever being able to make a living. There is a tendency to return to the old system of trade guilds, which has, in fact, grown notably during the past few years, and it is believed that this decentralisation of industry will give it stability, and that by international co-operation there will be an adjustment of exchanges which will avoid risk of massive unemployment amongst skilled men in the future. This movement does not, of course, encroach on engineering trades in which the independent master craftsman can play little part, except as a supplier to big firms, but it indicates a growing tendency on the Continent to decentralise lighter industries in which native artistry, initiative, and skill are required to maintain a high standard of quality.

Engineers' Degrees.

There is at present before the Senate the Bill for giving a legal status to engineers which was passed by the Chamber of Deputies and repudiated by engineering societies and institutions on the ground that it aimed at legalising a state of things that could not be allowed to continue. Amongst other strongly criticised provisions, the Bill recognised degrees granted by private correspondence schools, and the measure was intended, in fact, to democratise the profession by offering facilities for obtaining degrees. It is now being examined by a Commission of the Senate, which has suppressed the clause recognising diplomas granted by correspondence schools, and it is to be replaced by another clause making the conditions for obtaining degrees much more stringent.

Shipping.

The total tonnage of ships laid up in French ports on October 15th last was 846,233, a reduction of 93,914 tons as compared with the returns six weeks previously. In this total there were twenty-three passenger steamers, amounting to 173,794 tons, and 232 cargo ships, of an aggregate tonnage of 639,934. The reduced tonnage of ships laid up has followed upon the reorganisation of the shipping services and the putting of ships in commission.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

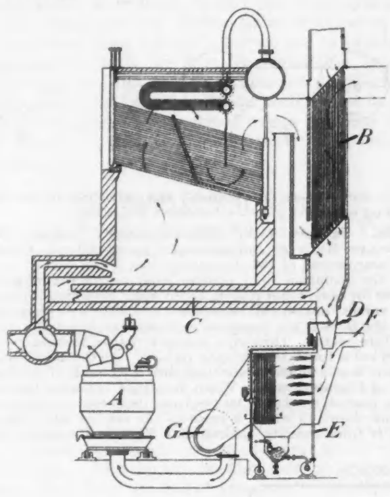
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

400,881. June 10th, 1933.—Gas-fired Boilers, Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.4.

This boiler is fired with gas from the producer A. It is aimed to provide a uniform quality of gas and prevent the formation of clinker. In the uptake of the boiler there is an air preheater B. The heated air is delivered partly by the duct C to the combustion chamber of the boiler and partly by the duct D to the humidifier E. This air is mixed with fresh cold air from the inlet F and is forced into the producer by the fan G. It will be observed that waste heat is used to supply the vapour necessary for the working of the producer, so that the boiler is relieved of the necessity of producing that much steam.—*November 2nd*, 1933.

N°400.88ı

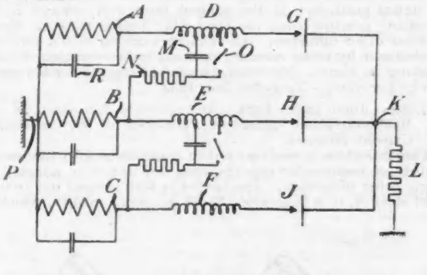


TRANSFORMERS AND CONVERTERS.

400,634. January 22nd, 1932.—Electric Converting Apparatus, Dr.-Ing. Erwin Marx, of 3, Rankestrasse, Braunschweig, Germany.

In accordance with this invention a rectifier with spark gaps is used for rectifying H.T. polyphase current. Connected to the phases A, B, and C of the three-phase transformer are the choke coils D E F, which are connected to three rectifying spark gaps G, H, and J of the plate-point type. Conductors are carried from these spark gaps to the D.C. conductor K to which is connected the D.C. load represented as a pure resistance L. When both positive and negative half-waves of an A.C. voltage are rectified, and when a considerable capacity is available between the continuous current line and earth, it is advisable not to connect the zero point P to earth. The undulation of the continuous current voltage to earth will then be very slight, more particularly in the case of an uneven number of phases of the transformer. The ignition of the spark gaps is effected in accordance with the invention by means of an auxiliary voltage. The current circuits for generating this auxiliary voltage are shown in the phases A and B. The capacity M is charged through the protective resistance N. O is a mechanical interrupter of the spark jump type, which causes the condenser to discharge across a portion of the series inductance E at the instant at which ignition is desired. The consequent oscillation produces at the gap G a high voltage which ignites the arc. The oscillation is kept away from the transformer by the capacity R and the resistance N prevents the occurrence of an interphase short circuit. The theory of the apparatus is explained.—*October 23rd*, 1933.

N°400.634

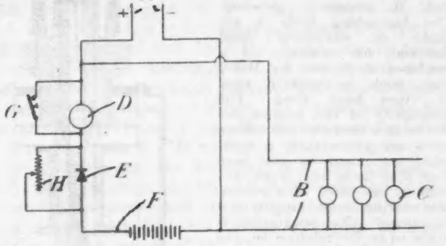


BATTERIES AND ACCUMULATORS.

400,246. April 18th, 1932.—Control of the Flow of Current in Electric Circuits, Thomas Frederick Edwin Watson, and the Westinghouse Brake and Saxby Signal Company, Ltd., both of 82, York-road, King's Cross, London, N.1.

This invention is particularly applicable to the charging and discharging circuits of secondary batteries in which for many purposes it is desired to limit the charging rate to a definite value, which may be relatively low, as in the case of trickle charging, while permitting a discharging rate which is unlimited or relatively high. The positive and negative circuit conductors of a source of direct current are indicated at A, the conductors being directly connected to conductors B connected to a load C, which is thus directly supplied with current from the supply conductors. The positive conductor is also connected in series with an ammeter D and a dry surface contact rectifier E to the positive terminal F of a secondary battery, the negative terminal of which is connected to the negative supply. The rectifier E is so connected in circuit that charging current supplied from the supply conductors to the battery traverses the rectifier E in its reverse or high resistance direction, an adjustable resistance H being connected in shunt to the rectifier. A switch G is provided for short-circuiting the ammeter D, this switch being normally closed and being adapted to be manually opened when it is desired to measure the current traversing the rectifier E. The operation of the apparatus is as follows:—Under normal conditions the load C is supplied with current directly from the supply conductors, while the battery is at the same time being trickle charged by current supplied from the conductors A through the closed switch G, the rectifier E, and the resistance H. The magnitude of this charging current is partly dependent upon the reverse direction resistance of the rectifier E, and partly on the value of the variable resistance H, the actual charging current supplied to the battery being indicated when desired by opening the switch G, so as to cause this current to traverse the ammeter. In the event of failure in the supply of current from the conductors A the battery will supply current to the load circuit conductors B, and it will be observed that this current will traverse the rectifier E in its normal or low resistance direction, so that flow of current to the load C from the battery will be relatively unimpeded.—*October 18th*, 1933.

N°400,246

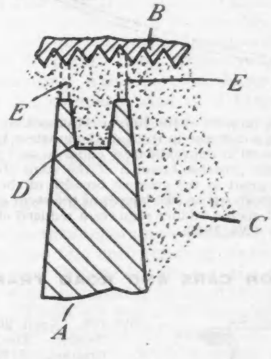


TRANSMISSION OF POWER.

400,882. June 10th, 1933.—Centrifugal Clutches, Pulvis Aktiengesellschaft, Glarus, Switzerland.

In those forms of centrifugal clutch in which the torque is transmitted from the driving part A to the driven part B by the resistance of a granular mass of material C, it is, naturally, essential that the moving part should be strong enough to resist the rotary thrust of the granular material. The result is that with ordinary constructions the moving part is so thick that a hard mass of the material builds up round the periphery of the rotor and makes the operation of the clutch harsh. As a consequence the inventors cut a groove D in the periphery of the driver and claim that then the compacting effect is only produced between the narrow limits of the broken lines shown at E E.—*November 2nd*, 1933.

N°400,882

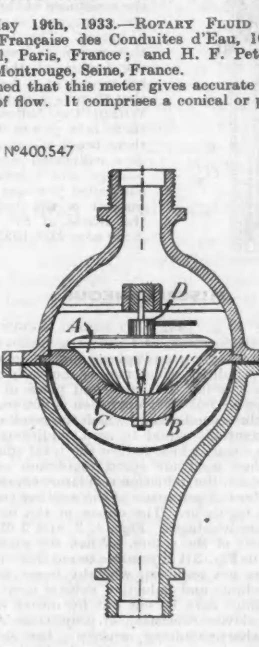


MEASURING AND TESTING INSTRUMENTS.

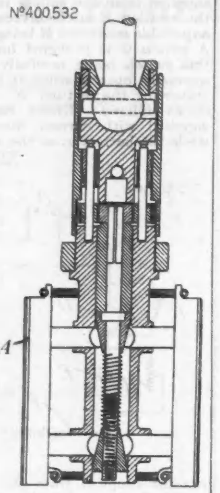
400,547. May 19th, 1933.—Rotary Fluid Meters, Compagnie Française des Conduites d'Eau, 106–108, Rue de Lourmel, Paris, France; and H. F. Petot, 11, Passage Morel, Montrouge, Seine, France.

It is claimed that this meter gives accurate readings over a wide range of flow. It comprises a conical or paraboloid rotor A placed in a correspondingly shaped bowl B. This bowl is perforated with tangential nozzles C, which direct the water on to the rotor. The rotor is free to rise and fall and takes up a position appropriate to the amount of water passing. It drives a counting mechanism D.—*October 26th*, 1933.

N°400.547



MACHINE TOOLS AND SHOP APPLIANCES.



Nº400532

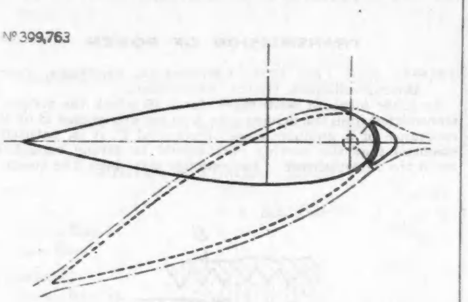
400,532. April 25th, 1933.—Finishing Cylinder Bores, E. Ryser, 7, Rue Hubner, Mulhouse, Haut - Rhin, France.

For the purposes of finishing the bores of, for instance, internal combustion engines, the surface is burnished by means of a tool such as that illustrated. The bore is, of course, first prepared by machining and, if necessary, grinding. The burnishing tools A are made of extremely hard material, for example, of a hardness of 90 deg. by Moh's scale, such as tungsten steel or other hard steel. The peculiarity of the process lies in the fact that the burnishing tools are given such a rapid axial movement in the bore that they make only from one-fifth to one-third of a revolution during each longitudinal movement. No suggestion is made as to the relative lengths of the tools and the bore to be burnished.—*October 26th*, 1933.

SHIPS AND BOATS.

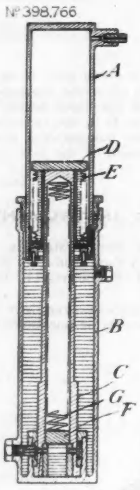
399,763. June 10th, 1933.—Rudders, Deutsche Schiff-und Maschinenbau Aktiengesellschaft, Bremen, Germany, and F. Schleufe, Wesermünde-Geestemünde, Germany.

Claim is made for: "A steering rudder having a fixed rudder stem, of which the complete cross section is of curved symmetrical water-cutting form, the greatest breadth of the rudder cross section projecting beyond the greatest breadth of the stem cross section, and the pivotal axis being at a distance in front of the greatest breadth of the rudder cross section, in which the pivotal axis is a distance in front of the greatest breadth of the rudder cross section approximately equal to said greatest cross section and the greatest breadth of the stem cross section is about half as great as the greatest breadth of the rudder cross section, but greater than the length of the stem cross section." It is said that such a rudder requires a reduced effort to put it over.—*October 12th*, 1933.



Nº399,763

MOTOR CARS AND ROAD TRAFFIC.



Nº398,766

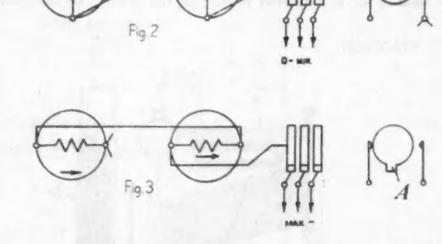
398,766. April 20th, 1933.—Shock Absorbers, M. Charles, 217, Boulevard Saint-Denis, Courbevoie, Seine Department, France.

It is suggested that this shock absorber may be also used as a carrying spring. The load is applied between the two telescopic parts A and B. Within the lower part B there is a hollow piston-rod C, carrying a piston D, which, with the assistance of the compressed air entrapped above, acts as a spring. The lower face of this piston is connected with the bottom of the cylinder A by means of a bellows E, so that there is a fluid-tight joint. Within the hollow piston-rod there is a piston F, on which there bears a spring G. There is a calibrated communicating passage, and a series of valve-controlled passages between the interior of the bellows E and the inside of the casing B.—*September 21st*, 1933.

MISCELLANEOUS.

400,714. June 14th, 1932.—Universal Induction Regulators, Josef Sousedík, of Vsetín, Czechoslovakia.

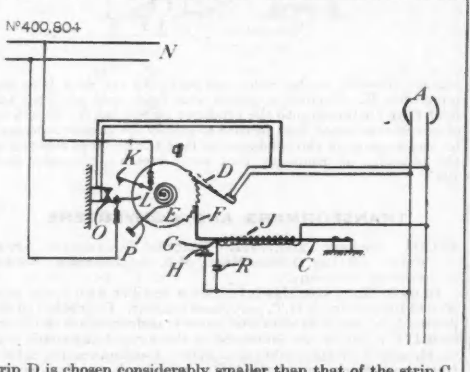
Induction regulators for multiphase currents comprising two stator and rotor windings, which may be mutually displaced and which serve for varying the value and phase of the induced voltage, are known; but their operation is not economical. In the position of the secondaries in which the resultant secondary voltage is substantially equal to zero, additional ohmic and inductive losses occur, which reduce the total efficiency of the apparatus. When used for speed regulation of multiphase commutator motors, the induction regulators employed hitherto do not provide for compensation of the wattless current in each position of the regulator. The object of the invention is to remove these disadvantages. Figs. 1, 2, and 3 illustrate three different positions of the rotors. When the rotors are in the position shown in Fig. 2 it is possible to cut out the rotor windings, as they are not required, whereby losses which may be caused by the ohmic and inductive voltage drop are avoided. The rotor windings may be cut out by means of a slip ring short-circuiting device consisting of projections A on the slip rings and by short-circuiting brushes. The short-circuiting position of the slip rings is shown in Fig. 2. In the third position—Fig. 3—the induced voltages of the rotors are added together, but as in this position the currents flow in the opposite direction to that indicated in Fig. 1, the resulting value is a minus quantity. For the purpose of adjustment of the phase displacement one of the stators B C is mounted so that it can be turned, and, if necessary, it is also connected by means of a suitable mechanical gear with the rotors in order to adjust the phase displacement, as is, for instance, desirable in the speed regulation of commutator motors for obtaining any particular power factor, including a leading phase.—*November 2nd*, 1933.



Nº400,714

400,804. January 11th, 1933.—Electric Thermal Time-delay Relays, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, U.S.A.*

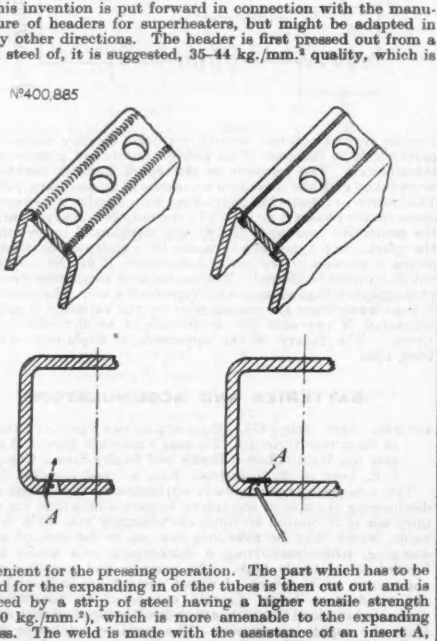
By the operation of a control relay on the occurrence of a fault or for some other reason, and if some switching process has to be carried out on this occurrence and after a certain lapse of time, the lines A are energised and thus the bimetallic strips C and D are heated. The strip C moves upwards, moving the wheel E forward a tooth through the pawl F. At the same time the contacts G and H are opened and thus the circuit of the heating winding J is interrupted. When the strip C is heated the strip D is also heated, so that it moves from its dotted position to the position shown in which it rests on the ratchet wheel and prevents it from running backwards. The time constant of the strip D is chosen considerably smaller than that of the strip C, so that its first switching stroke can be utilised. After a certain number of operations of the strip C contact K meets contact L and thus closes the working circuit N, which causes the operation of a signal or the carrying out of switching processes. By the interruption of the contacts O the heating current of strip D is interrupted. As soon as the latter has cooled down sufficiently to free the ratchet wheel and the pawl F has moved back into its initial position the spring P can move the wheel E back into its initial position. If the control relay still remains in its operating position then the time-relay begins to work afresh without other influence. An efficient working of the contacts is obtained by using mercury contacts or interruption devices working in vacuo. Moreover, parallel connected condensers R can be provided.—*November 2nd*, 1933.



Nº400,804

400,885. June 16th, 1933.—Autogenous Welding, N. V. Machinerieen-en Apparaten Fabrieken, of 30, Croeselaan, Utrecht, Holland.

This invention is put forward in connection with the manufacture of headers for superheaters, but might be adapted in many other directions. The header is first pressed out from a mild steel of, it is suggested, 35–44 kg./mm.^{2} quality, which is convenient for the pressing operation. The part which has to be drilled for the expanding in of the tubes is then cut out and is replaced by a strip of steel having a higher tensile strength (41–50 kg./mm.^{2}), which is more amenable to the expanding process. The weld is made with the assistance of an insert A, which is tacked in position and holds the welding metal in place during the work.—*November 2nd*, 1933.



Nº400,885

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day.

Inst. of Chemistry.—30, Russell-square, W.C.1. Fifth S. M. Gluckstein Memorial Lecture. "The Chemist as a Directing Force in Industry," Dr. Herbert Levinstein. 8 p.m.

Inst. of Electrical Engineers: N. Eastern Centre.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 for 7.30 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Discussion, "Heat Transfer between Metal Pipes and a Stream of Air," Dr. Ezer Griffiths and Mr. J. W. Awbery. 6 p.m.

Inst. of Structural Engineers: Midland Counties Branch.—At James Watt Memorial Inst., Birmingham. Discussion on "Welded Structures," 7 p.m.

Inst. of Structural Engineers: Western Counties Branch.—At Merchant Venturers' Technical College, Bristol. "Reinforced Concrete Bridges," Mr. J. T. Gueritte. 7.15 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "General Principles Governing Cable Network, Design and Maintenance in Large Towns," Mr. E. W. Carline Day. 8.30 p.m.

N. East Coast Inst. of Engineers and Shipbuilders.—Mining Inst., Newcastle-upon-Tyne. "Modern Practice in Ships' Steering Gear," Messrs. W. J. Paulin and W. Spencer Paulin. 6 p.m.

Physical Soc.—In Chemical Technology Dept., Imperial College of Science and Technology, Prince Consort-road, S.W.7. Meeting, 5 p.m.; Editing Committee, 3 p.m.: Council meeting, 3.30 p.m., at 1, Lowther-gardens, S.W.7.

Railway Club.—Broad-street Station Restaurant, E.C. Annual dinner.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse, "Industrial Research: A Business Man's View," Mr. Kenneth Lee. 9 p.m.

Friday and Saturday, December 15th and 16th.

Northampton Polytechnic Inst.—St. John-street, E.C.1. Annual prize distribution, Friday, 7 p.m. Annual conversazione, Saturday, 6.30 p.m.

Saturday, December 16th.

Inst. of Electrical Engineers: N. Midland Students.—Visit to Messrs. Marshall, Kay and Marshall, Dewsbury. 3 p.m.

Inst. of Electrical Engineers: S. Midland Students.—Visit to works of West Midland Sugar Company, Ltd., Foley Park, Kidderminster. 3.30 p.m.

Inst. of Engineers-in-Charge.—Visit Express Dairy Company's Research Laboratories, Claremont-road, Cricklewood, N.W.2. 2.30 p.m.

Manchester Assoc. of Engineers.—At College of Technology, Manchester. Conversazione and dance. Reception 6.45 p.m.

N. of England Inst. of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. Meeting, 2.30 p.m.

Sheffield Metallurgical Assoc.—198, West-street, Sheffield. Young people's party. 3.30 p.m.

Monday, December 18th.

Inst. of Automobile Engineers.—At Inst. of Engineers and Shipbuilders, 39, Elmbank-crescent, Glasgow. "Technical Aspects of the Design of the 'Blue Bird' Racing Car," Mr. R. A. Railton. 7.30 p.m.

Inst. of Electrical Engineers: S. Midland Students.—At James Watt Memorial Inst., Birmingham. "Carrier Current Telephony," Mr. D. R. Turner. 7 p.m.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Handling of Materials at Modern Gasworks,' Mr. J. B. Urquhart. 6.45 p.m.

Tuesday, December 19th.

Inst. of Civil Engineers.—Great George-street, S.W.1. Prof. W. T. David will present for discussion "The Working Fluid of Internal Combustion Engines." 6 p.m.

Inst. of Electrical Engineers: Scottish Centre.—At Royal Technical College, Glasgow. "Cathode Ray Oscillograph and Some of its Applications," Mr. Geoffrey Parr. 7.30 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow, C.2. "Mechanical Methods of Solution of Stresses in Frames," Dr. C. H. Lobban. 7.30 p.m.

Inst. of Production Engineers: Yorkshire Section.—Hotel Metropole, Leeds. "The Functions of a Planning Department," Messrs. J. G. Young and J. Greatrix. 7.30 p.m.

Wednesday, December 20th.

Inst. of Automobile Engineers.—At Engineers' Club, Albert-square, Manchester. "Repairs," Mr. J. Dent. 7 p.m.

Inst. of Engineers and Shipbuilders in Scotland.—Gordon Restaurant, Gordon-street, Glasgow. Luncheon. 1 p.m.

Inst. of Civil Engineers.—Great George-street, S.W.1. Students' meeting. Vernon-Harcourt Lecture. "Canals," Mr. J. A. Saner. 6.30 p.m.

Inst. of Production Engineers: Birmingham Section.—At James Watt Memorial Inst., Birmingham. "Some Scientific Fallacies, Paradoxes, and Peculiarities," Dr. D. S. Anderson. 7 p.m.

Royal Meteorological Soc.—49, Cromwell-road, S. Kensington, S.W.7. Meeting, 5 p.m.

Royal Microscopical Soc.—B.M.A. House, Tavistock-square, W.C.1. Meeting. 5.30 p.m.

Thursday, December 21st.

Crystal Palace School of Practical Engineering.—Crystal Palace, S.E. Presentation of certificates by Mr. Walter Henry Haile. 3 p.m.

Inst. of Electrical Engineers.—Savoy-place, W.C.2. "Electromagnetic Phenomena in High-voltage Testing Equipment," Mr. B. L. Goodlet. 6 p.m.

Inst. of Locomotive Engineers.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Steam Motive Power Operation," Mr. T. H. Shields. 6 p.m.

Inst. of Production Engineers: Glasgow Section.—At 39, Elmbank-crescent, Glasgow. "The Function of the Production Engineer," Mr. R. Taylor. 7.30 p.m.

N. East Coast Inst. of Engineers and Shipbuilders.—At Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. Tees-side Branch. "Superheated Steam in Marine Service," Mr. William Hoy. 7.30 p.m.

1934.

Thursday, January 4th.

Inst. of Metals: Birmingham Local Section.—James Watt Memorial Inst., Birmingham. "Nickel and Nickel Alloys," Mr. W. R. Barclay. 7 p.m.

A Seven-Day Journal

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Fire Protection in Cross-Channel Ships.

ON Tuesday, December 19th, the 400ft. turbine-driven cross-Channel steamer "Princess Maud," designed by William Denny and Brothers, Ltd., was successfully launched at Dumbarton, the naming ceremony being performed by Lady Craigavon, wife of the Premier of Northern Ireland. The new steamer will be used on the L.M.S. Larne-Stranraer service and is designed to carry some 1250 passengers. It is noteworthy that all her cabin accommodation, public rooms, corridors, &c., are protected against fire by an equipment which has been designed and installed by the patentees, Mather and Platt, Ltd., of Manchester. It comprises about 400 Quartzoid bulb sprinklers, divided into four installations, each installation having its own controlling valves and automatic alarm. Fixed in the chart room is an indicator, which, upon the sounding of an automatic alarm, shows the particular section that has been brought into operation. Although the "Princess Maud" is the first British-built vessel to be so protected, it may be recalled that in 1914 Mather and Platt installed "Grinnell" sprinklers in certain parts of the two German-built vessels, the "Imperator" and the "Vaterland," now the "Berengaria" and the "Leviathan," respectively, and that these partial equipments are still in good order and operative in the event of fire.

The Late Mr. D. M. Shannon.

IT is with deep regret that we have to record the death, at the comparatively early age of fifty-one, of Mr. David McCrorie Shannon, a well-known personality in the marine oil engine industry. Mr. Shannon received his early training with Vickers Ltd. at Barrow-in-Furness and for some years was attached to the firm's oil engine department. Shortly after the outbreak of war he joined Cammell Laird and Co., Ltd., of Birkenhead, and as head of the oil engine department was responsible for the design and construction of the Camellaird-Fullagar opposed-piston two-stroke oil engine, which was subsequently fitted to many ships and applied for land work. In 1926 Mr. Shannon joined the Fiat Company and was responsible for the introduction of the Fiat oil engine into Great Britain and the establishment of Fiat British Auxiliaries, Ltd. Quite recently Mr. Shannon designed a successful oil fuel lubricating oil filter called the "Rotoklene" strainer, which we have described. After a short time with the Newbury Diesel Company, Ltd., of Newbury, Mr. Shannon took up an appointment as sales engineer with the "R.N." Diesel Engine Company, Ltd., of Altrincham and London, in whose service he was at the time of his death. He had many friends in the marine oil engine industry, and his untimely death shortly before he was to have been married will be widely regretted, both in this country and abroad.

The Use of Coal at Sea.

AT a meeting of the Marine Fuel Committee of the Coal Utilisation Council, which was held on Wednesday, December 13th, problems attending the use of solid fuel in sea-going vessels were exhaustively examined, and it was decided that in the near future steps should be taken to increase the consumption of coal at sea in opposition to the use of imported oil fuels. To achieve this end, it was decided to set up two sub-committees not too large to be effective, which will report to the main committee. One of these committees will consider the specification and supply of coal for marine purposes, while the other will be entrusted with the task of dealing with up-to-date plants for the efficient utilisation of coal at sea. The committees will make their recommendations at an early date. The Marine Fuel Committee is a representative body of shipowners, colliery owners, research officers, marine engineers, and superintending engineers, from among whom the following members have been chosen for the two sub-committees above referred to. The members of the Fuel Committee are: Messrs. J. Harrison, W. J. Drummond, H. H. Merrett, R. Addy, Edward W. Green, J. Johnson, T. F. Hurley, Leighton Seagar, S. Gill; and those of the Machinery Committee, Mr. A. E. Laslett, Engineer Rear-Admiral W. M. Whayman, Mr. R. J. Walker, Engineer Captain Dunlop, and Mr. J. Johnson.

National Certificates and Diplomas in Mechanical Engineering.

As briefly mentioned at the meeting of the Institution of Mechanical Engineers, held on Friday evening, December 15th, Lord Irwin, the President of the Board of Education, recently received the President of the Institution, Mr. Alan Chorlton, and several others closely associated with the National Certificates scheme, notably Dr. H. S. Hele-Shaw, F.R.S., Past-president, who has been Chairman of the Joint Committee from its inception until the present time. Lord Irwin expressed the opinion which is widely held in the world of technical education, that the national certificate schemes as a whole are proving one of the most valuable educational developments since the war. He recognised the value of a painstaking and detailed administration which is the only means by which initial vision can be turned into a well-ordered, trusted, and popular national institution. Time has shown that the original conception of the national certificates and diplomas contained this element of vision, and he noted that in that matter the Institution of Mechanical Engineers was first in the field, and that the scheme with which it is associated is still the largest. He believes that among many of the best of those who have not had the opportunity of a university education, no need is more deeply felt than for some means to acquire the sense of status in their chosen profession, such as nationally attested qualifications based upon educational attainments, together with industrial experience, can effectively confer. For such students the national certificate schemes have, for the first time, offered the opportunity they desired, and it is probably to this that their great and deserved popularity is mainly to be attributed. It may be added that similar schemes are in operation in conjunction with the Scottish Education Department, and the Ministry of Education in Northern Ireland, and that in other fields besides mechanical engineering similar co-operation exists between other professional institutions and these Government Departments.

The New Orient Liner.

THE new Orient liner to be built by Vickers-Armstrongs, Ltd., which was briefly referred to in one of last week's Journal notes, will have a distinctive appearance, as she will only have one funnel and one mast, whereas the other ships in the Orient Line fleet all have two funnels and two masts. The change has been rendered possible by the introduction of water-tube boilers which has made it possible to do away with one set of uptakes. The propelling machinery will comprise a twin-screw arrangement of geared turbines, taking steam from oil-fired water-tube boilers, and designed to give an output of about 24,000 shaft horse-power. The speed of the new ship will be greater than that of the "Orontes," which is 20 knots. The length of the new liner will be 665ft., which is more than that of existing vessels of the fleet, while her beam has been increased in order to provide for substantially larger cabins. She will be designed to carry 475 first-class, and, instead of third-class, 675 tourist class passengers. A feature of the accommodation will be the larger number of single-berth cabins and an increased number of private bathrooms. The games deck, always one of the principal features of Orient liners, will, in the absence of a second funnel, be large and exceptionally free from encumbrances.

The Late Mr. S. E. Saunders.

BY the death of Mr. Samuel Edward Saunders, which took place in the Isle of Wight on Sunday, December 17th, Great Britain has lost a leading designer and builder of racing motor boats. Mr. Saunders, who was president of Saunders-Roe, Ltd., and was seventy-seven years of age, began business at Goring-on-Thames, but moved his works to East Cowes in the Isle of Wight, where many noteworthy racing boats were built and lifeboats constructed for the Royal National Lifeboat Institution. Two of the most famous racers were the "Ursula," a 50ft. boat built for the Duke of Westminster, which for four successive years won nearly every Monte Carlo event; and "Mapleleaf the Fourth," constructed for Sir E. Mackay Edgar, which in 1912 won back the Harmsworth International Trophy from America and successfully defended it in the Solent the following year. Shortly before the war Mr. Saunders took up the construction of flying boats, and in conjunction with Mr. Tom Sopwith designed and built what was stated to be the first amphibian flying boat. It carried off the Mortimer Singer prize of £500 for seven consecutive landings on land and sea. Mr. Saunders introduced sewn plywood construction for use in his racing craft and flying boats. He was a member of the Institution of Naval Architects and of the Royal Motor Yacht Club and the Royal London Yacht Club. He held a Royal warrant as motor yacht builder to the King and was a well-known figure during Cowes week.

Fuel Oil for Central Heating.

AN interesting demonstration of oil-fired central heating plant took place at the end of last week in the Glasgow offices of Scottish Oils and Shell-Mex, Ltd. The plant, which has been recently installed, comprises automatic burners designed to utilise a heavy grade of oil fuel with thermostatic temperature control. In emphasising the importance of oil-fired central heating to Scotland, Mr. G. P. Laidlaw, the manager, pointed out that in the Scottish shale oil industry over 4000 men were employed in the shale fields alone, irrespective of those employed in marketing, distribution and the allied industries. Mr. N. L. Hudson, of London, said that there were now in operation in this country between 9000 and 10,000 fuel oil burners, of which about 700 were in Scotland. The first completely automatic oil burners were those introduced from America about six years ago, but such burners had suffered almost total eclipse in face of those designed by British firms. Among the most successful of such firms were the Clyde Oil Fuel System, Ltd., of Glasgow and London, and Laidlaw, Drew and Co., Ltd., of Edinburgh, which companies had developed oil fuel burning equipment which allowed the heavier grades of oil fuel to be used without loss of efficiency and with a saving of approximately 20s. per ton compared with other fuels.

The Late Mr. G. J. Churchward.

THERE is not a railway man who will not hear with profound regret of the tragic death of Mr. G. J. Churchward, who for many years was locomotive superintendent of the G.W.Ry., and the designer of many notable locomotives. A few years after the war, Mr. Churchward retired, but he continued to live in the company's house. It stands beside the line at Swindon, and it was Mr. Churchward's habit to cross the rails to the works in which he still took a lively interest. On Tuesday last, his mutilated body was found on the line after the passage of the Fishguard express, and it is supposed that, owing to a slight mist and his failing eyesight, he miscalculated the speed of the approaching train. We shall publish a memoir of his life and work in our next issue.

John Brown and Co., Ltd.

ON Wednesday of last week, December 13th, the announcement was made that Lord Aberconway, who, for the past twenty-seven years, has been the chairman of John Brown and Co., Ltd., shipbuilders and colliery proprietors, has, on grounds of health, retired from that position. He will be succeeded by his eldest son, the Hon. Henry McLaren, the deputy chairman of the company, who, for some time past, has taken a leading part in the activities of his firm and has now been appointed its chairman. Lord Aberconway, who was born in 1850, and is now, therefore, in his eighty-third year, is also chairman of numerous iron, coal, steel, and other industrial companies. He is a Vice-president of the Federation of British Industries. The new chairman, the Hon. Henry McLaren, is chairman of Thomas Firth and John Brown, Ltd., deputy chairman of the Tredegar Iron and Coal Company, Ltd., and a member of the board of Dorman, Long and Co., Ltd., and several other companies. In his long period of office, Lord Aberconway has seen many outstanding warships and liners built and engined by his company, and it is fitting that his son's succession in the leadership of his firm should coincide with the promise of an early resumption of work on the new Cunarder.

A Large Palestine Water Scheme.

FURTHER particulars are now available with regard to the steel pipe line and pumping stations recently ordered by the Crown Agents for the Colonies in connection with the scheme for supplying Jerusalem with water. There are about 31 miles of 18in. steel pipes, and four pumping stations, with a reservoir at each station. From the Ras-el-Ain springs the pipe line will follow the railway to Lludd and from that point the road from Jaffa to Jerusalem. As recently recorded in our Market Notes and News, the contract for the pipe line has been placed with Stewarts and Lloyds, Ltd., and will be probably executed at the firm's Airdrie works. The oil engines will comprise twelve medium-speed vertical oil engines, each of 350 B.H.P., using heavy fuel oil, and will be built by the National Gas and Oil Engine Company, Ltd., of Ashton-under-Lyne. Each engine will drive a seven-stage centrifugal pump, and the pumping plant will be supplied by the Harland Engineering Company, Ltd. The scheme is to be proceeded with immediately, and it is understood that the construction will be in the hands of the Public Works Department, under the direction of Mr. Fawcett Pudsey, the Director of Public Works in Palestine.

A Brazilian Naval Training Ship.

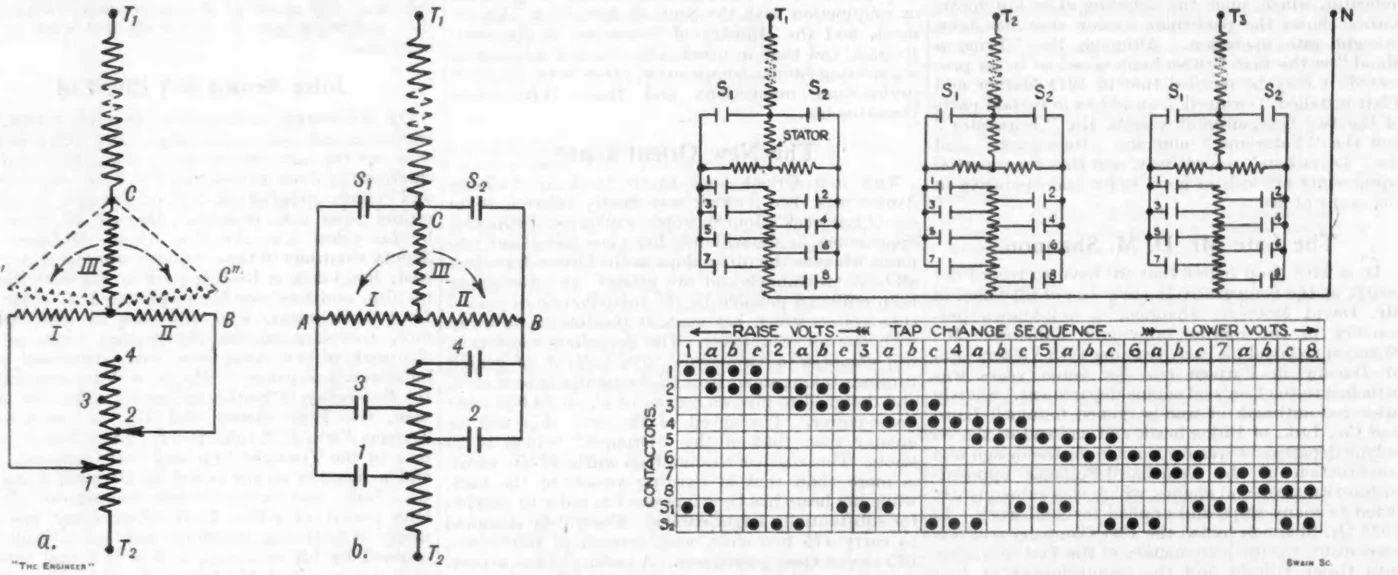
THE launch of the Brazilian naval training ship, "Almirante Saldanha," from the Barrow shipyard of Vickers-Armstrongs, Ltd., on Tuesday, December 19th, was noteworthy, not only for the interesting character of the vessel, but on account of the fact that it was the first launch from the Barrow-in-Furness shipyard made since September, 1932. The launching and naming ceremony was performed by Madame Regis de Oliveira, the wife of the Brazilian Ambassador, who represented Madame Getulio Vargas, the wife of the President of Brazil. The "Almirante Saldanha" is a four-masted sailing ship, equipped with oil engines for auxiliary propelling and lighting purposes. Her total sail area will be about 27,000 square feet, and her engines have a total of 1400 B.H.P. She has a length of 262ft. 6in., a breadth moulded of 52ft., and a depth of 28ft. 6in., with a measurement of about 2500 gross tons. Speaking at the luncheon following the launch, Sir Herbert Lawrence stated that the contract for the vessel had been obtained at a higher price than those quoted by other countries, but there were other factors besides price. The ship is the first of nine vessels now in various states of construction at Barrow and awaiting launching, and the keel of the new Orient liner will be laid early next year.

A.C. Voltage Regulators.

No. V.

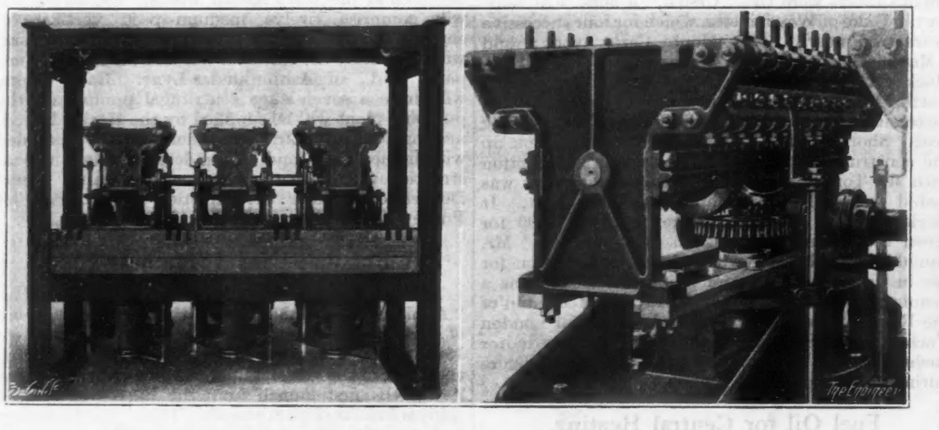
(Continued from page 603, December 15th.)

APART from the more or less recent introduction of several types of A.C. regulators mainly for use on low-pressure distribution systems, progress is still being made in the design of on-load tap-changing gear for attachment to transformers with capacities up to the largest required. A new equipment of this kind, known as type V X C O, has been introduced by the Hackbridge Electric Construction Company, Ltd., of Walton-on-Thames. Smooth and continuous pressure variation is obtained with no disturbance of the line conditions, and with no continuous magnetising loss or change of phase displacement. All switching operations are performed by cam-operated contactors, which give a rapid break. The maximum current broken is merely the magnetising current of a special intermediate regulator, which is connected between two adjacent tappings during the short period of each change. The lower limit of transformer size to which the apparatus can be economically applied, is largely a matter of relative cost. For transformers below about 1500 kVA another equipment* is manufactured giving a smooth variation at a cost in keeping with that of relatively small transformers. The principle of connecting a regulator across the tappings when making a voltage change is not, of course, new. One of the early tap-changing transformers built by the Hackbridge Company† had an intermediate regulator, but the present equipment is designed on different lines.



CONTACTORS.	← RAISE VOLTS. —⇇ TAP CHANGE SEQUENCE. ⇉— LOWER VOLTS. →																												
	1	a	b	c	2	a	b	c	3	a	b	c	4	a	b	c	5	a	b	c	6	a	b	c	7	a	b	c	8
1	●	●	●	●																									
2		●	●	●	●	●	●	●																					
3						●	●	●	●	●	●	●																	
4										●	●	●	●	●	●	●													
5														●	●	●	●	●	●	●									
6																		●	●	●	●	●	●	●					
7																						●	●	●	●	●	●	●	
8																										●	●	●	●
S_1	●	●						●	●	●						●	●	●						●	●	●			
S_2				●	●	●						●	●	●						●	●	●						●	●

FIGS. 49 AND 50—CONNECTIONS FOR ON-LOAD TAP-CHANGING EQUIPMENT WITH A REGULATOR BETWEEN TAPPINGS



FIGS. 51 AND 52—THREE-PHASE, TAP-CHANGING EQUIPMENT AND DRIVING GEAR

The intermediate regulator which is brought into operation during each tap change in the equipment under consideration resembles an induction regulator with a wound rotor and stator. One end of the stator winding is connected through a slip-ring to the mid-point of the rotor winding, and the other end to the main transformer winding. The ends of the rotor winding are connected *viâ* slip rings through switchgear to adjacent tappings on the transformer winding, as shown in Fig. 49 (*a*), in which for the sake of clarity winding III. is shown as the moving element, although in practice A B moves in relation to III., which is stationary. The regulator is wound, so that if the rotor is in the position in which section I. of the rotor winding is in the maximum and section II. in the minimum relationship to the stator III., position C′ in Fig. 49, the fluxes in I. and III. are opposed, while those in the windings II. and III. are additive. Consequently in this position the reactance and therefore the voltage between A and C will be zero, and between B and C a maximum. Similarly, if the rotor is turned so that winding II. is in the maximum relationship and winding I. in the minimum relationship to the stator III., *i.e.*, position C″, Fig. 49, the voltage between B and C will be zero and that between A and C a maximum. Thus by turning the rotor through 180 electrical degrees the voltage of C is varied smoothly from the pressure at one end of the rotor to that at the other end, and since the ends A and B of the rotor winding are connected to adjacent tappings, the rotation of the rotor varies the potential of C from the voltage of one tapping to that of the next. In practice the connections between the ends of the rotor winding A and B and the transformer tappings are made and broken by cam-operated contactors. Two contactors operated in the same way are also employed for short circuiting the regulator windings from C to A or C to B, in order that when the tap change has been completed the transformer load current does flow through the regulator windings.

SEQUENCE OF OPERATION.

The actual circuit of a single-phase equipment is shown in Fig. 49 (*b*). In changing from tapping No. 1 to No. 2, in order to raise the voltage, the sequence of operations is as follows :—Before the change begins the short-circuiting contactor S_1 and tapping contactor 1 will be closed, whilst all other contactors will be open, the regulator position being C′—Fig. 49 (*a*). Tapping contactor No. 2 then closes, thus connecting the regulator across tappings 1 and 2. Next, contactor S_1 opens, but it does not break any current, for with the regulator in the position C′ the point C is at the same potential as A, *i.e.*, the potential of tapping No. 1. The regulator is then turned to the position C″, thus smoothly raising the potential of C to that of B, *i.e.*, to the voltage of tapping No. 2. Contactor S_2 then closes, thereby connecting C directly to tapping No. 2, and diverting the transformer current from the regulator winding. Finally, contactor No. 1 opens and merely breaks the magnetising current of the regulator, since the reactance from C to A is now at a maximum. The tap-changing operation is now complete. A three-phase equipment comprises three identical single-phase units arranged to operate in the manner described, and connected in star, as shown in Fig. 50, or in delta according to requirements. The chart accompanying Fig. 50 shows the complete switching sequence covering the whole range of tappings, the regulator rotating 180 deg. after each operation *b*.

MECHANICAL ARRANGEMENT.

The contactor and regulator assembly is illustrated in Fig. 51, which shows the equipment removed from the tank in which it normally operates, and disconnected electrically from the transformer and mechanically from the operating gear. The latter, which may be motor or hand controlled, is normally coupled to one end of the horizontal main shaft, which couples the three single-phase units for three-phase operation. In each unit both the vertical regulator shaft and the horizontal cam shaft that operates the contactors are driven by a single worm gear on the main shaft, as illustrated in Fig. 52, which shows the driving worm meshing with a worm wheel at the top of the regulator shaft, and also with a worm wheel which drives the contactor cam shaft. As indicated above, the main driving shaft actually consists of three shafts, one serving each phase unit joined together for electrical reasons by insulating sections. On each unit the steel shaft carrying the driving worm runs in two bearings, and is coupled to the adjacent insulating section through a coupling having a reasonable degree of flexibility. The contactor assembly is illustrated in Fig. 53, which is a plan view of this portion of the equipment. The tap-changing contactors are arranged in two rows A A. Along the centre and below the level of the contactors is the square shaft B, rotated by the worm wheel C, which, as explained, is driven by a worm gear on the main shaft. On this square shaft is a cam D, having a spiral contour similar to that of a worm gear, and a bore of square section. Rotation of the shaft therefore causes rotation of the cam which is a sliding fit on the shaft and can therefore move longitudinally. On either side of the cam shaft and level with it are two toothed racks, the teeth of which engage with the convolutions of the cam, as shown diagrammatically in Fig. 54. Consequently, when the

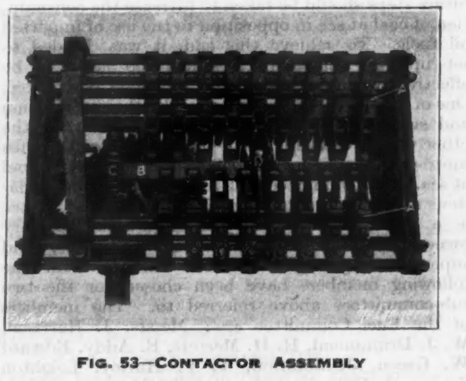


FIG. 53—CONTACTOR ASSEMBLY

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* See THE ENGINEER, August 11th, 1933.

† See THE ENGINEER, July 12th, 1929.

cam shaft is rotated the cam not only rotates but also moves along the shaft, and as it does so the cam face engages in turn with the rollers at the ends of the arms operating the contactors, which are thus closed, held closed, and opened in the correct sequence. Flicker blades fitted to the "start" and "finish" of the cam contour ensure rapid opening of the contactors. Mounted behind the cam shaft worm wheel, but hidden from view in Fig. 54, are two other contactors operated by simple cams and corresponding to the switches S_1 and S_2 in Fig. 50. From this description it will be clear that when the main shaft of the equipment is rotated, either by hand or motor, the cam shaft of each phase is rotated, thereby operating the necessary contactors to complete the tap change, while at the same time each regulator rotor is turned through the requisite arc, with the result that a smooth stepless voltage variation is obtained between tappings. The framework, Fig. 51, into which the whole of the equipment is built closely fits into the oil-filled boiler plate tank, and with the disconnection of the flexible coupling that joins the end of the main shaft to the external driving gear and the removal of the various tapping connections, the equipment can be lifted straight out of the tank for inspection or other purposes.

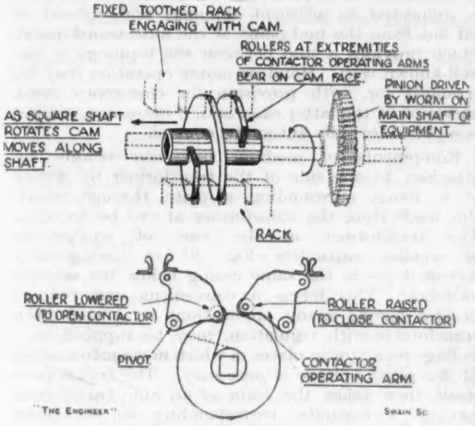
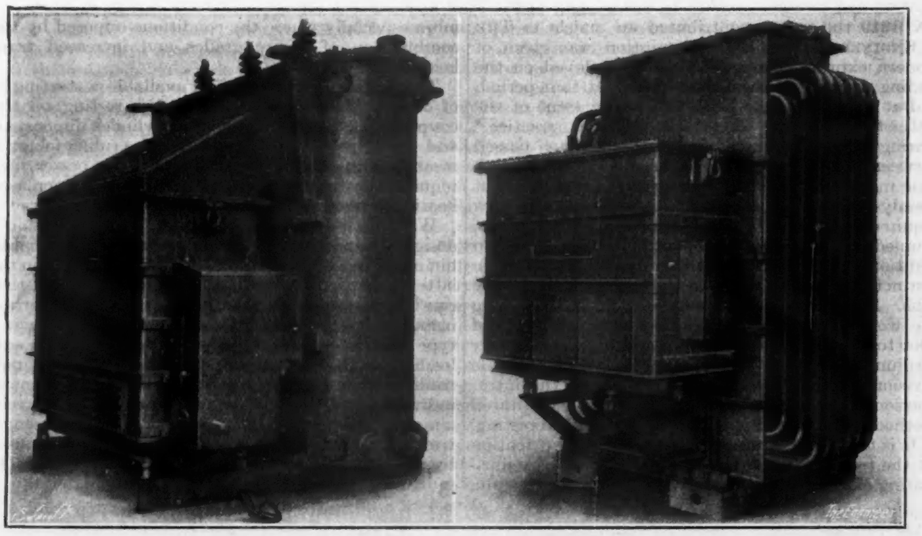

FIXED TOOTHED RACK ENGAGING WITH CAM.
ROLLERS AT EXTREMITIES OF CONTACTOR OPERATING ARMS BEAR ON CAM FACE.
PINION DRIVEN BY WORM ON MAIN SHAFT OF EQUIPMENT
AS SQUARE SHAFT ROTATES CAM MOVES ALONG SHAFT.
RACK
ROLLER LOWERED (TO OPEN CONTACTOR)
ROLLER RAISED (TO CLOSE CONTACTOR)
PIVOT
CONTACTOR OPERATING ARM
"THE ENGINEER"
SWAIN SC

FIG. 54—CAM MECHANISM



FIGS. 55 AND 56—REMOTE AND MANUALLY-CONTROLLED ON-LOAD TAP-CHANGING TRANSFORMERS

When the operating pressure is above approximately 33 kV the three units are insulated from one another and from earth by means of porcelain insulators. Below this pressure the units are mounted on two longitudinal beams of selected and treated wood to be seen in Fig. 51. Between the units the wood is serrated, as shown, to increase the leakage path, and the weight of the equipment is taken by steel angles on which the insulating beams rest. Connections to the regulator rotors are made through slip rings at the bottom of each unit, and inspection doors with bolt-on covers in the tank side facilitate inspection of the brush gear and rings. The mid-point rotor terminal is connected in each case to the regulator carcase, which is insulated from earth and, as stated, from the adjacent units of a three-phase equipment. As is shown in Fig. 52, the studs for connecting the equipment to the transformer tappings are arranged at the top of the contactor assemblies.

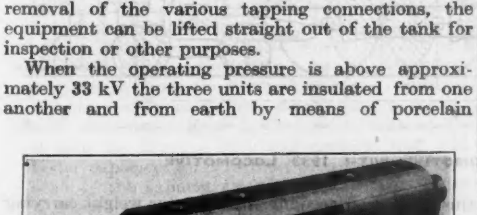


FIG. 57—ROTOR FOR BARBOUR REGULATOR

DRIVE AND CONTROL.

The steel cubicle housing the drive, control, and indicating mechanism is housed outside the tank, as illustrated in Fig. 55, which shows a tap-changing equipment designed for remote or for manual control fitted to a 10,000-kVA three-phase 22/11-kV transformer. For automatic or remote controlled operation this cubicle contains the motor drive together with the motor and auxiliary contactors, indicating and limit switches, &c. For outdoor operation the cubicle is naturally made waterproof. The manually controlled equipment, shown in Fig. 56, is fitted to a 2500-kVA 11/2·1-kV transformer. Motor-operated equipments have the requisite means for hand operation and a simple mechanical interlock prevents motor operation while tap changing by hand. Interlocks also ensure that a motor-driven equipment accurately completes each tap change, while overrun of the mechanism at either end of the tapping range is prevented by separate pairs of limit switches. Various indicators of the multiple lamp or dial patterns are fitted.

The choice of such equipment is largely determined by the distance between the tap-changing gear and the indicating point, the number of pilot wires available, and similar considerations. All equipments, however, are fitted with a mechanically operated indicator similar to that to be seen at the side of the drive and control cubicle in Fig. 55, such indicators being scaled in terms of tapping positions, plus or minus voltage percentages as required. Automatic or remote control generally follows normal practice. Without alteration the control system is suitable for parallel operation of two or more equipments from a common push button control point, the requisite precautions being taken to ensure that under normal conditions the tap changers will all keep in step.

THE BARBOUR REGULATOR.

The Barbour regulator differs from the ordinary induction regulator in that there are no windings on the laminated rotor core, which, as Fig. 57 shows, is more or less rectangular with rounded ends. The stator is, of course, also laminated and it carries both the primary and secondary windings, which are placed in the large slots P P and S S respectively—Fig. 58. As these windings are not distributed in a large number of small slots it is a relatively simple matter to insulate these regulators for high voltages. The makers, the Electrical Apparatus Company, Ltd., of Vauxhall Works, South Lambeth-road, also claim that this arrangement of the windings improves the electrical characteristics and promotes silence. When the rotor of a polyphase regulator of this kind is in the neutral position no voltage is induced in the secondary and there is no phase shift in this position. For a given direction of primary magnetising current, and therefore magnetic flux, the flux in question passes in different directions through the secondary when the rotor is in the alternative positions indicated by the full and dotted lines. The voltage induced in the secondary changes its sign correspondingly. Halfway between these positions the rotor will stand with its ends directly facing the secondary slots and the primary flux will pass partly into the rotor from pole 1 and out at pole 4 and will also pass partly in from pole 2 and out at pole 3. In this mid-position, therefore, none of the primary flux passes through the secondary and consequently no voltage is induced in it. In other intermediate positions, however, a certain amount of flux passes through the secondary, the effect as a whole therefore being that as the rotor is turned from the "full on" position in one direction through 90 deg. to the "full on" position in the other direction the voltage induced in the secondary gradually falls to zero and then rises again with reversed sign.

For remote or fully automatic working two systems of control are employed. On large regulators an auxiliary motor is used with reduction gearing, clutch and lever for emergency hand operation, reversing contactors, brake and a control drum with limit switches and contacts for a remote control indicator, when required. All these items are mounted in a suitable enclosure. For fully automatic working a new and patented voltage relay has been devised, with a thermal element responsive through the intermediary of a potential transformer to the voltage under control.

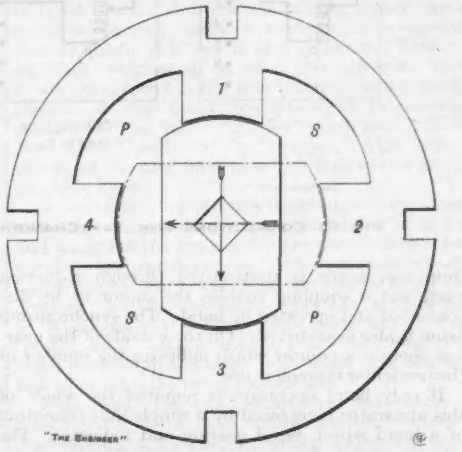


FIG. 58—ROTOR AND STATOR

A typical Barbour regulator removed from its tank is shown in Fig. 59. The upper bearing bracket is integral with the top casting carrying the driving mechanism, terminal chamber and accessories. The rotor, Fig. 57, is built on a central steel plate having bearing journals and a square driving part cast integral with it. On each side of the plate there are laminations and copper plates to control the magnetic flux, the whole being clamped together by means of bolts. There are no slip rings or flexible leads, for the rotor consists solely of steel and copper. The regulators are made for single and three-phase supplies for the voltage regulation of feeders, &c. They are also used in conjunction with on-load tap-changing equipment and as controllers and starters. When used in conjunction with tap-changing equipment, the Barbour regulator gives, as in the case of the Hackbridge apparatus, a gradual change of voltage without shock to the transformer or system.

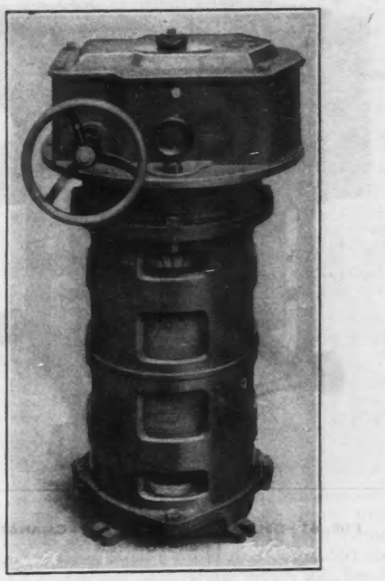


FIG. 59—BARBOUR REGULATOR

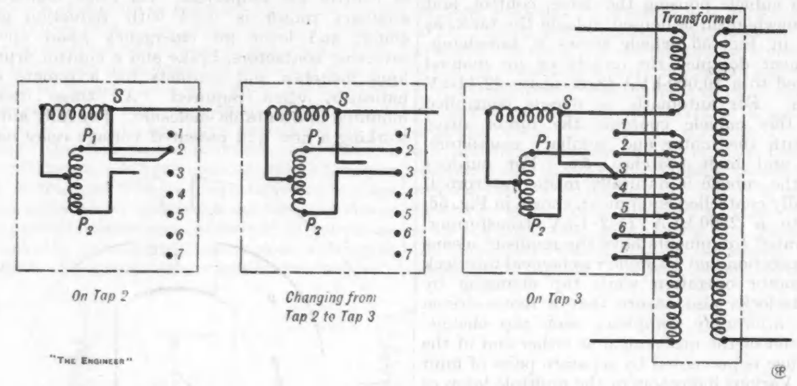
TAP-CHANGING EQUIPMENT WITH BARBOUR REGULATORS.

The Electrical Apparatus Company's on-load tap-changing equipment is contained in an oil-filled casing attached to the tank of the transformer it is desired to control. Enclosed in a waterproof box above this casing is the driving mechanism, which, in the case of automatic control, comprises an electric motor, a pair of interlocked reversing triple-pole contactors for starting and stopping the motor, a drum synchronised with the selector switches, and having segments to prevent over-run, and, if necessary, to give remote indication of the transformer tapping in use. There is also a pair of maintaining switches which, once a tapping change has begun, keeps the motor running independently of any other control until the change is completed and ensures that the selector switches make full contact. Power from the motor is transmitted through reduction gear, and a coupling enables the motor to be disconnected and operated by hand. The synchronising drum is also gear-driven. On the outside of the gear-box there is a pointer which indicates the number of the particular tapping in use.

If only hand operation is required the whole of this apparatus is replaced by a simple unit consisting of a hand wheel, bevel gearing and indicator. The selector switch for each phase consists of a drum controller of standard design, except for the fact that the fingers are mounted on substantial round bakelite tubes without a metal core. Although the method of applying a Barbour regulator to tap-changing equipment is similar to that described, we reproduce the makers' diagram of connections in Fig. 60. In this case, it is to be remembered, there are no slip rings or brushes. The inner end of the secondary winding is permanently connected to the mid-point of the primary P_1 and P_2, while the outer end S of the secondary is permanently connected to that point on the main transformer winding which is to be joined to the various tappings.

When full on a given tapping, the outer secondary end S and one end of the primary are also in connection with the tapping, the other end of the primary being disconnected, as shown on the left of Fig. 60. In changing to the next tapping, say, from 2 to 3, the free end of the primary is first connected to tapping 3, and the point S of the secondary is disconnected from tapping 2 in the manner shown in the centre of the diagram, the rotor of the Barbour controller being in the position in which no voltage is being generated between these points. The effect of disconnection is, therefore, merely to cause the line current to flow through one-half of the primary and through the secondary against their self-impedance. The rotor of the controller is then gradually turned to reverse the controller voltage so as to change the voltage of S from that of the tapping being taken out of service to that of the tapping that is being brought into use.

The point S is then connected to the new tapping as shown on the right of Fig. 60 without involving any change of voltage, but merely cutting out the impedance of the induction controller. At the same time the end of the primary connected to the tapping, from which the transfer has been made, is disconnected. The only switching operations necessary are those for making or breaking the small magnetising current of the Barbour controller and those for connecting or disconnecting two points which, apart from a small amount of self-impedance, are at equal potentials.



On Tap 2

Changing from Tap 2 to Tap 3

On Tap 3

FIG. 60—CONNECTIONS FOR TAP-CHANGING EQUIPMENT WITH BARBOUR REGULATOR

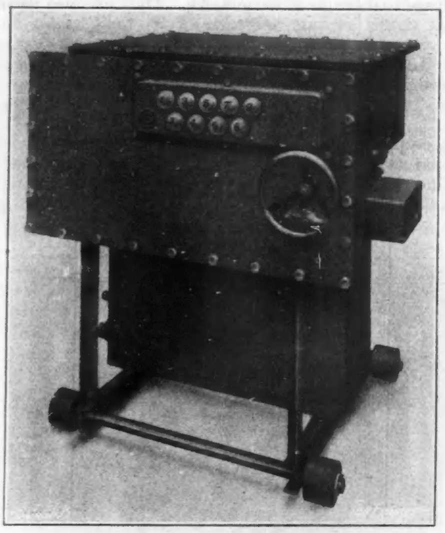


FIG. 61—SMALL ON-LOAD TAP-CHANGING TRANSFORMER

A more simple and less expensive on-load tap-changing equipment built by the Electrical Apparatus Company, Ltd., is shown in Fig. 61. It cannot be made for such large capacities as the apparatus described, and, like most other equipments, it changes the voltage suddenly. Drum controllers make and break circuit without the use of special contactors. The rapid step to step motion is under the control of a spring, which is wound up while the controllers are held fixed, while, on the release of the controllers the spring throws them to the next position, where they are again held fixed. On alternate steps connection is made direct to a transformer tapping, while on intermediate steps an auxiliary auto-transformer is connected to adjacent tappings and current is led out from the mid-point of the auto-transformer, which provides a step between the tappings in the well-known way. Hand or motor operation may be arranged for, with provision for emergency hand operation in the latter case, and, if necessary, a relay is supplied for fully automatic control.

Equipments of medium size, can readily be attached to one side of the transformer by means of a flange surrounding a plate through which the leads from the transformer are to be brought. The transformer in the case of equipments of smaller capacities—Fig. 61—is conveniently mounted inside the same casing below the selector switches. This forms a convenient unit, which, besides having many applications as a step-down transformer with regulation, may be supplied as a voltage regulator in places in which no transformation of the rated voltage is necessary. The transformer itself then takes the form of an auto-transformer having a capacity corresponding to the boost required.

(*To be continued.*)

Recent American Express Locomotives.

By E. C. POULTNEY.

No. I.

IN 1919 the writer contributed an article to THE ENGINEER in which a description was given of modern express passenger engines employed on the leading railways of the United States at that period, and at the same time he briefly noted some of the distinctive features found in American practice.* During the intervening years which have passed between the date of the earlier review and the present time many changes have taken place, brought about mainly by demands for greatly increased power now required to handle heavier trains at high speeds, coupled with improved operating efficiency. In addition there has during more recent years been a distinct tendency to augment the length of locomotive runs. In order to satisfy such requirements involving the working of passenger trains weighing upward of 1000 tons behind the tender either at high speeds over medium-grade lines, or unaided over heavy grade divisions at lower mean speeds, has caused the introduction of engines of high power and necessitated methods of construction both novel and interesting.

It is the writer's present purpose to draw attention to the trend of modern American practice by illustrating examples which typify recent designs covering the six-coupled and eight-coupled types, as now used on some of the principal railway systems.

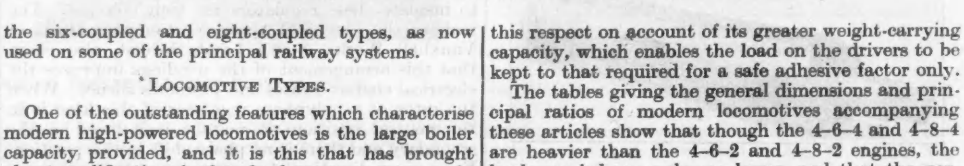


FIG. 1—COMPARISON OF 1893 LOCOMOTIVE WITH 1933 LOCOMOTIVE

LOCOMOTIVE TYPES.

One of the outstanding features which characterise modern high-powered locomotives is the large boiler capacity provided, and it is this that has brought about modifications in the wheel arrangements now in evidence, compared with the prevailing practice at the time the earlier review was written. Formerly the majority of locomotives built for fast passenger services were of the "Pacific" type, having the 4–6–2 wheel formation, but the same reasons which made it necessary in the earlier stages of development to change from the 4–4–0 to the "Atlantic," and from that to the "Pacific," have in turn led to a modification of the latter, and produced the 4–6–4 arrangement, while at the same time the "Mountain" or 4–8–2 is giving place to the 4–8–4 type now found, more especially where the conditions imposed by the combination of heavy grades and increased train loads are to be met.

The maximum tractive effort available at starting is, of course, governed by the weight resting on the coupled axles, together with the cylinder dimensions and steam pressure, but at speed the ruling factor is steam production, and to maintain the power now required has necessitated the provision of increased heating surfaces and larger grates.

With both the "Pacific" and the "Mountain" designs, considerable heating surface is attainable, but in the matter of fire-box and grate area, and in the latter in particular, the limit is set by the weight that can be supported by the trailing truck. In certain instances very powerful engines of the "Pacific" type may be employed, owing to high allowable axle loading for the coupled axles, thus relieving the single trailing axle; but this is not always so, and in general individual weights on the coupled axles do not exceed a maximum of 70,000 lb., especially for fast passenger traffic, because of the increased rail loading caused by the dynamic augment at high speeds. The four-wheeled trailing truck has helped materially in this respect on account of its greater weight-carrying capacity, which enables the load on the drivers to be kept to that required for a safe adhesive factor only.

The tables giving the general dimensions and principal ratios of modern locomotives accompanying these articles show that though the 4–6–4 and 4–8–4 are heavier than the 4–6–2 and 4–8–2 engines, the loads carried per axle are lower, and that the percentage of the engine weight carried by the driving wheels is not so high, but at the same time an adequate adhesive factor is maintained.

When considering these features, and especially when comparing the relative tractive efforts, it will be seen that the tractive effort of the 4–6–4 and 4–8–4 engines is not greater than for the 4–6–2 and 4–8–2 designs, but the increased boiler capacity enables these engines to generate much more power at high speeds, and, as will later be shown, it is now possible to develop 1000 I.H.P. per coupled axle.

In carrying further a comparative study of these locomotive types it will be seen that the four-wheeled trailer has made it possible to provide grate areas proportionate to the larger heating surfaces, that the engine weight per square foot of combined heating surface is generally rather lower for the modified "Pacific" and "Mountain" designs, and further, more heating surface is provided in relation to the cylinder power, as shown by the boiler demand factors. This increase in heating surface in proportion to the cylinder capacity, together with the larger grates made possible by the introduction of the four-wheeled trailing truck, are directly responsible for the high sustained powers developed by modern 4–6–4 and 4–8–4 engines.

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* THE ENGINEER, May 30th and June 6th, 1919.

TABLE I.—*Examples of Recent Passenger Locomotives of the 4–6–2 and 4–6–4 Types.—General Dimensions and Ratios.*

Railway	C.R.R. of N.J.	B. & O.	Penn.	So. Pac.	N.Y.C.	C.M. & St. P.	A.T. & S.F.	B. & A.
Type..	4–6–2	4–6–2	4–6–2	4–6–2	4–6–4	4–6–4	4–6–4	4–6–4
Date	1931	1927	1929	1928	1931	1930	1927	1928
Cylinders, diameter and stroke, inches ..	26 × 28	27 × 28	27 × 30	25 × 30	25 × 28	26 × 28	25 × 28	25 × 28
Driving wheels, diameter, inches..	74	80	80	73½	79	79	73	75
Boiler working pressure	240	230	250	200	225	225	220	240
Rated tractive force, lb.	52,180	50,000	54,675	43,660	42,300	45,820	44,900	44,800
Heating surfaces, square feet :								
Tubes and flues	3,190	3,452	3,980	3,069	4,203	3,794	3,842	4,203
Fire-box	401	394	305	283	281	411	314	281
Total evaporative	3,591	3,846	4,285	3,352	4,484	4,205	4,156	4,484
Superheater..	1,000	932	1,634	836	1,951	1,815	980	1,951
Combined	4,591	4,778	5,919	4,188	6,435	6,020	5,136	6,435
Grate area	84·3	70·3	69·89	70·5	81·5	80·0	88·0	81·5
Weights, lb.:								
On drivers	205,900	201,000	207,600	187,700	187,000	189,720	198,400	187,500
On leading truck	63,830	63,000	54,200	61,800	65,000	79,930	65,300	65,000
On trailing truck	64,100	62,000	56,900	63,800	100,000	106,200	85,800	100,500
Engine total	333,830	326,000	318,700	313,300	352,000	375,850	349,500	353,000
Tender	253,900	214,000	245,000	291,100	302,700	289,150	287,000	204,600
Locomotive	587,730	540,000	343,200	604,400	654,700	665,000	636,500	557,600
Ratios :								
Weight on drivers, per cent. of total.. ..	61·67	60·6	65·2	59·8	53·2	50·5	56·8	53·1
Engine weight ÷ comb. heating surface ..	72·71	68·2	53·7	74·9	54·6	62·4	68·0	64·9
Adhesive Factor..	3·94	4·02	3·8	4·3	4·42	4·14	4·42	4·18
R.T.F. × dia. of drivers ÷ comb. heat. surface	841	837	737	766	519	602·5	638	522
Superheat surface, per cent. of combined	21·8	19·5	27·6	20·0	30·3	30·15	19·1	30·3
Comb. heat. surface ÷ grate area	54·46	68·0	84·5	59·4	79·0	75·2	58·4	79·0
Superheater type	A	A	E	A	E	E	A	E

BOILERS AND SUPERHEATERS.

Beyond an increase in size, boiler construction has not changed materially, though the higher working steam pressures now general have directed attention to the use of special steels with weight reduction as an object.

Usually, the fire-box is formed with a combustion chamber extending forward into the barrel section, and Nicholson thermal syphons are very frequently applied, both in the fire-box itself, where they form a support for the arch, and in the combustion chamber.

One constructional feature of interest is the now very usual practice of welding together all the plates for the internal fire-box and for the combustion chamber. The tubes and flues are also welded into the rear tube sheet.

All locomotives, as a matter of course, use superheated steam, and whereas formerly the type A equipment was commonly employed, the type E superheater is now very largely used. This superheater has much larger heating surfaces and, moreover, forms a greater proportion of the boiler, for, compared with the type A with a heating surface equal to about 20 per cent. of the total combined, this figure for the E type superheater is about 30 per cent. In addition to the large heating surface, the flues housing the elements make up a greater part of the total free area through the boiler, which are therefore exposed to a larger proportion of the heat liberated by the fire-box. The use of this superheater has considerably increased the amount of superheat and improved cylinder efficiency and the power output.

Feed-water heating is receiving much attention, and, in general, all the most recent locomotives are fitted with feed heaters of the closed or open types, complete with pumps.† The exhaust steam injector has also been fitted to some extent; that used is known as the Elesco pattern, which is a modification of the Metcalf design. The Sellars injector is also used, but so far as the writer is aware, the feed-water heater with pump, the latter either of the reciprocating or rotary (turbine-driven) description, is much the most common. Feed heating with exhaust steam is held to improve fuel performance, and add to boiler capacity, and, further, as about 12 or 15 per cent. of the exhaust steam from the main cylinders is recovered for feed purposes, the equivalent of added tank capacity is obtained.

An examination of modern engines shows that there is a tendency to fit the regulator or throttle valve in the smoke-box where it can be arranged between the superheater and the steam chests. This permits the auxiliaries, including the air compressors, feed pumps, and the booster and stoker engine to use superheated steam, whilst, as steam is always in the elements, they are protected against overheating when the throttle is closed. Furthermore, dampers, which would be inconvenient to fit in conjunction with the type E superheater, are unnecessary. For the purpose of isolating the superheater from the boiler, a shut-off valve is usually fitted to the steam pipe in the dome.

There is a decided tendency towards higher working steam pressures which range between the limits of 200 lb. and 275 lb. per square inch, while, experimentally, pressures of as much as 300 lb. have been tried in the normal type of boiler. Generally, however, pressures of 225 lb. or 250 lb. are found, and the Pennsylvania, after employing as standard for many years a pressure of 205 lb. has adopted 250 lb. for its most recent designs. The Chicago and North-Western has in service a number of very large 4–8–4 passenger engines operating at this figure, but the boilers and machinery are so constructed that the pressure may be raised to 275 lb. if required.

CYLINDERS, MAIN FRAMES, AND RUNNING GEAR.

The high power of modern engines has prompted considerable development work in the construction of the main framing to stand the stresses set up by the necessarily high piston loads, and the desire to reduce weight has been a further factor which has been instrumental in modifying the design and construction of both the cylinders and frames. Cast steel has been very largely introduced for cylinders, which are either cast with the half-saddle in this material, or in pairs in one piece with the saddle and valve chests complete. This type of construction has been used in conjunction with the usual separate frames with cross bracing members of cast steel, but the latest engines now have the whole of the main framing, including the cradle for the fire-box support and the cylinders, complete with piston valve chests, smoke-box saddle, and front bumper beam, with all brackets, made in one solid casting. In certain instances, the hind cylinder covers and the reservoirs for the air brake, have also been included, these being arranged between the side members and in the centre of the engine. Some of these locomotive bed frames have reached large proportions; for instance, those for some heavy 4–8–4 engines for the Chicago and North-Western weigh as much as 72,500 lb., or, say, 33 tons of 2240 lb. Cast steel cylinders are lighter than cast iron, but are, of course, fitted with iron liners, as are also the piston valve chests.

TABLE II.—*Examples of Recent Passenger Locomotives of the 4–8–2 and 4–8–4 Types.—General Dimensions and Ratios.*

Railway	Penn. R.	C.R.I. & P.	B. & O.	D.L. & W.	C. & N.W.	G.N.	D.& R.G.W.	C.M. & St. P.	A.T. & S.F.
Type	4–8–2	4–8–2	4–8–2	4–8–4	4–8–4	4–8–4	4–8–4	4–8–4	4–8–4
Date..	1930	1929	1930	1927	1929	1930	1929	1930	1929
Cylinders, diameter and stroke, inches ..	27 × 30	28 × 28	27½ × 30	27 × 32	27 × 32	29 × 29	27 × 30	28 × 30	30 × 30
Driving wheels, diameter, inches	72	74	74	77	76	80	70	74	73
Boiler working pressure	250	200	250	250	250	225	240	230	210
Rated tractive force	64,550	50,400	65,000	64,500	65,200	58,300	63,700	60,000	66,000
Heating surfaces, square feet :									
Tubes and flues	4,303	4,069	5,015	4,700	4,656	4,402	4,471	4,860	5,132
Fire-box	395	368	491	493	558	379	446	540	540
Total evaporative	4,698	4,437	5,506	5,193	5,214	4,781	4,917	5,400	5,672
Superheater	1,634	1,327	2,451	1,324	2,357	2,265	2,229	2,403	2,426
Combined	6,332	5,764	7,957	6,517	7,571	7,046	7,146	7,803	8,098
Grate area	69·86	63·0	92·3	88·2	100·0	97·7	88	103·0	108·0
Weights, lb.:									
On drivers	271,000	255,500	260,000	269,000	288,000	247,300	252,000	258,814	272,880
On leading truck	59,000	63,000	62,000	62,500	87,000	78,000	64,000	79,330	65,410
On trailing truck	60,000	59,500	63,000	89,500	123,000	95,600	92,500	112,694	93,950
Engine total	390,000	378,000	385,000	421,000	498,000	420,900	408,500	450,838	432,240
Tender..	378,360	194,000	273,000	216,000	320,000	326,900	269.500	289,162	292,260
Locomotive..	758,360	572,000	658,000	637,000	818,000	747,800	678,000	740,000	724,500
Ratios :									
Weight on drivers per cent. of total ..	69·4	67·7	67·5	64·1	57·7	58·7	61·7	57·3	63·1
Engine weight ÷ comb. heat. surface ..	61·5	65·7	47·2	64·5	65·9	59·8	57·2	57·4	53·3
Adhesive factor	4·2	5·07	4·0	4·17	4·42	4·24	3·96	4·3	4·13
R.T.F. × dia. of drivers ÷ comb. heat. surface	733	647	604	762	655	663	621	567	597
Superheat surface per cent. of combined..	25·8	23	30·8	20·3	31·1	32·2	31·2	30·8	30·1
Combined heat. surface ÷ grate area ..	79·3	91·5	86·0	73·8	75·7	72·1	81·6	76·4	74·7
Superheater, type	E	A	E	E	E	E	E	E	E

As is well known, the two-cylinder engine is, for all practical purposes, universal in American practice, and all the designs now under notice are of this description. To obtain the high powers necessary, the cylinders must be of considerable size, and the diameters range generally between 25in. and as much as 30in., with, consequently, high piston loads to be transmitted through the motion and framing. In considering this, it must, however, be remembered that the bar type of main frame, when compared with that of plate construction, is particularly well adapted to meet the stresses imposed, and makes it possible to provide an adequate support for the axle-boxes, as the centre of the boxes and the journal bearings can coincide with the centre line of the side members of the main frames. So far as motion parts are concerned, alloy steels are frequently used, and the older strap form of big end for the connecting-rods is giving place to a solid end fitted, as a rule, with floating bushes, which are also often applied to the side rod pins.

In order to reduce reciprocating weights, crosshead design is receiving attention, and the Laird type is much used. Another underhung design having multiple bearing surfaces working in a specially formed single slide bar is also common. This construction originated on the Pennsylvania, where it was introduced in the first place for heavy freight engines, its use being now extended to passenger engines of the later "K. 4's" and new "K. 5" and "M 1" and "M 1 *a*" classes. This type of crosshead has also been fitted by Baldwin to engines for other lines.‡

On account of the stresses imposed, and the weight to be carried, journal bearings must be of large size, and those for the main axles are always larger than for the other coupled axles. Axles are usually hollow bored, and so are crank pins, the weight being thus reduced; but the practice is especially useful where, as is generally the case, these parts are of heat-treated steel. Main driving boxes are now often fitted with supplementary adjustable side bearings, as well as with the usual crown brass.

While the one-piece locomotive bed frame is, possibly, one of the most notable features of modern construction, a further interesting innovation is the growing use of roller bearings, more especially for tender and engine trucks, though experiments are being made now with roller bearings on the coupled axles. Machine friction will be reduced by this form of journal bearing, but reduced maintenance costs and increased availability are the primary considerations.

TENDERS.

The large engines now in use naturally require considerable supplies of fuel and water; consequently, large tenders are provided. Fuel space has increased from about 12 tons to as much as 28 or more in certain instances, and in like manner the amount of water carried has risen from 8000 to over 22,000 gallons, U.S. measures in both instances. The use of these large tenders has eliminated special stops for re-fuelling and taking water, and has been a factor in enabling the extension of locomotive runs, and has, therefore, played an important part in reducing operating costs.

Examples of very large tenders as applied to fast passenger locomotives are to be found on the New York Central, where those fitted to the "Hudson" class have a loaded weight of 302,700 lb., the fuel carried being 28 tons, 56,000 lb., and the tank capacity 14,000 gallons, whereas the standard "Pacifics" of 1920 had tenders of 168,000 lb. weight, when loaded with 8000 gallons of water and 12 tons of coal.

On the Pennsylvania the latest K. 5 "Pacifics" have tenders carrying 35,600 lb. of coal and 14,000 gallons of water, and a full weight of 244,900 lb., while the "M. 1 *a*" 4–8–2 engines have tenders turning the scale at no less than 378,360 lb., or

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† More than 90 per cent. of the new locomotives built in 1930 were fitted with feed water heaters.

‡ For a description see THE ENGINEER, May 15th, 1925, page 551.

168 long tons, which can carry 63,000 lb. of coal, and 22,000 gallons of water.

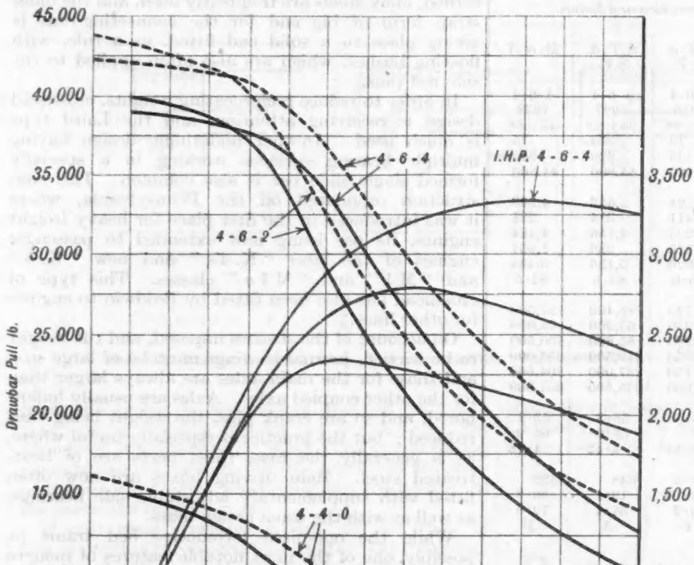


Fig. 2—Characteristics of 4-4-0, 4-6-2, and 4-6-4 Engines

The construction of these high-capacity tenders has been greatly facilitated by the development made in the design of the underframing, which now takes the form of a single steel casting, which makes at the same time a bottom for the tank. This has proved a very strong structure, necessary when it is considered that the length between the truck centres may be as much as 32ft., and the total length of the tank 48ft. or more. The tender sides are either riveted to the frames or welded, and often the whole upper part is welded together throughout, which makes a satisfactory construction, being strong and free from leakage; further, a neat finish is readily obtained. Tender trucks are of cast steel, frequently of the six-wheeled type. Rolled steel solid wheels, 33in. diameter, are practically standard, with journals of about 6½in. by 12in.

Increase in Size and Power.

Before describing representative examples of modern high-speed passenger locomotives, which have been selected for treatment, it will be of interest to note the increase in size of engines of this type. Fig. 1 shows to the same scale the N.Y.C. engine No. 999, built by Buchanan in 1892 and exhibited at the World's Fair in 1893, and a modern 4–6–4 "Hudson" type locomotive as now in use on the New York Central lines. The 4–4–0 or "American" type engine is superimposed on the 4–6–4, thus bringing out clearly the increase in size that has taken place during the last forty years of development, and it will be noted that the new engine is as large as the entire locomotive of 1892, including the tender. The comparative size of these engines as thus illustrated will be of further interest when reference is made to the next diagram, Fig. 2, in which the pull, speed, and horse-power are plotted for the 4–4–0 engine, a representative "Pacific" of 1918, and for the 4–6–4 "Hudson" of the present day. The leading dimensions and other data appertaining to these engines are given in Table III.

Table III.—*Comparative Particulars of Express Locomotives.*

Date	1893.	1918.	1927.
Wheel arrangement	4–4–0	4–6–2	4–6–4
Cylinders, dia. and stroke, in. ..	19×24	27×28	25×28
Driving wheels, dia., in...	86	79	79
Rated tractive force, lb...	16,200	43,900	42,300
Heating surfaces, sq. ft.—			
Evaporative	1,920	3,824	4,484
Superheater..	—	887	1,951
Total combined	—	4,711	6,435
Grate area, sq. ft.	30·7	70·8	81·5
Boiler working pressure..	190	200	225
Weight, lb.—			
Engine	124,000	306,000	352,000
On drivers	84,000	197,000	187,000
Tender	80,000	194,200	302,700
Total, locomotive	204,000	500,200	654,700
Superheat, deg. Fah.	—	200	250
Draw-bar pull at 60 m.p.h., lb. ..	2,988	12,616	15,997
Draw-bar horse-power at 60 m.p.h.	476	2,020	2,550
Heating surface per D.B.H.P. at 60 m.p.h.	4·03	2·32	2·52
Loco. weight, lb. per D.B.H.P. at 60 m.p.h.	427	247	256
Engine weight, lb. per sq. ft. total heating surface	64·5	65·0	54·6
Superheater type	—	A	E
Feed water heater	—	No	Yes
Tank capacity, galls, U.S.	3,587	10,000	14,000
Coal, lb.	13,800	32,000	56,000

Referring to the graph, the full lines represent the pull available at the rear of the tenders between 10 and 70 miles per hour, and the broken lines the indicated tractive effort at the cylinders. The D.B.H.P. curves are also shown for the three engines, and for the 4–6–4 the I.H.P. curve is plotted as well. In the lower part of the diagram are shown by the lines sloping upwards to the right the resistance offered by the trains. The upper curve relates to a modern passenger train of 1000 tons made up of 75-ton coaches, and the lower to the Empire State Express of 1892 made up of 35-ton cars and having a weight of 200 tons behind the tender.

Referring to the tabulated statement, it will be noted that the heating surface per D.B.H.P. at 60 m.p.h. has fallen from 4·03 square feet in 1893 to 2·52 square feet in 1927, the date when the first of the 4–6–4 engines was introduced, and that the locomotive weight per D.B.H.P. developed at 60 m.p.h. has during this period been reduced from 427 lb. to 256 lb. A similar comparison can also be made between the standard "Pacific" of 1918 and the 4–6–4, where it will be seen that although the latter engine has a tender weighing 302,700 lb., as against 194,200 lb. in the case of the "Pacific," representing an increase of 55 per cent., the locomotive weight is only 256 lb., D.B.H.P., equal to an as against 247 lb., per increase of 3·5 per cent.

If we now compare these engines on the basis of engine weight only—that is, comparing the weight of the actual power plant with the D.B.H.P. or net power available—the following figures are found:—

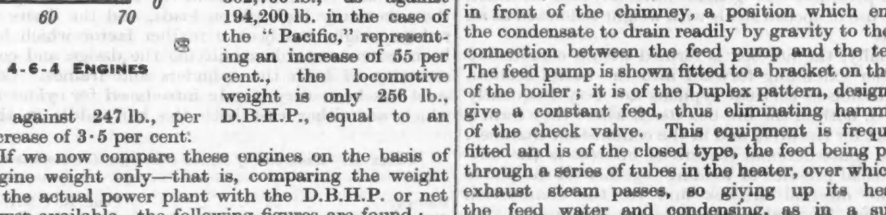
	4–4–0.		4–6–2.		4–6–4.
Engine weight per D.B.H.P., lb.	840	..	151	..	138
Weight on drivers per D.B.H.P. lb.	176	..	97·7	..	73·6

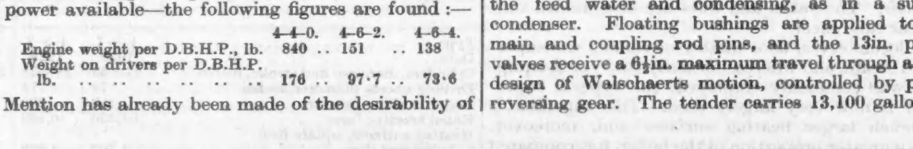
Mention has already been made of the desirability of restricting the weight carried by the driving axles, and in regard to this the improvement made in the power output in relation to the adhesive weight is of interest. Referring to the cylinder power developed per coupled axles, the I.H.P. curve for the 4–6–4 shows that at 60 m.p.h. the indicated horse-power reaches just over 3300, or more than 1100 I.H.P. per axle.

The data just discussed show the improvement in the power weight ratio, both in respect to engine weight and to that carried on the driving wheels when the adhesive factors are practically equal, and the horse-power curves indicate how, for a given rated tractive effort the actual power available at high speed has been increased. As bearing on this latter point it is interesting to quote from the *Railway Mechanical Engineer*, February, 1933, which made the following statement:—"The combination of the large fire-box, the type E superheater, and the four-wheeled trailing truck has converted the locomotive from a machine rated by its starting tractive force to one which is rated by its horse-power capacity," a statement which adequately sums up the ideas underlying modern locomotive design.

Locomotives of the 4–6–2 and 4–6–4 Types.

In the foregoing notes the writer has made no attempt to do more than outline the salient features of modern express locomotives, it being only desired to draw attention to certain constructional and other features, and it is now proposed to supplement the remarks already made by offering some descriptive notes relative to recent designs, supported by illustrations. The engines will be mentioned in the order in which they appear in the tables of dimensions. The first—Fig. 3—locomotive represents the latest "Pacific," as built by the Baldwin Locomotive Works, for service on the Central Railroad of New Jersey (C.R.R. of N.J.). Actually, these engines have been built to work fast and medium speed trains when the stops are frequent, and a high tractive effort is required for rapid starting. They follow in general design a number previously placed in traffic, but have smaller wheels, and an increased boiler pressure, so, though the cylinders are of equal size, the higher rated tractive effort of 52,189 lb. is obtained, compared with 46,841 lb. for those having the larger, 79in., wheels. The superheater is of the A type, but is of large size, having forty elements and 1000 square feet of heating surface, or 27 per cent. of the total combined surface. The fire-box has a combustion chamber, and the distance over the tube plates is 18ft. 8in. The 207 tubes are 2in. and the forty flues 5⅜in. diameter. A feed-water heater of the "Elesco" type is fitted, which is, as shown, mounted on the smoke-box in front of the chimney, a position which enables the condensate to drain readily by gravity to the feed connection between the feed pump and the tender. The feed pump is shown fitted to a bracket on the side of the boiler; it is of the Duplex pattern, designed to give a constant feed, thus eliminating hammering of the check valve. This equipment is frequently fitted and is of the closed type, the feed being passed through a series of tubes in the heater, over which the exhaust steam passes, so giving up its heat to the feed water and condensing, as in a surface condenser. Floating bushings are applied to the main and coupling rod pins, and the 13in. piston valves receive a 6½in. maximum travel through a light design of Walschaerts motion, controlled by power reversing gear. The tender carries 13,100 gallons of water, and 15 tons of coal, and has a cast steel water bottom underframe to which the side sheets are welded; all the internal bracing is also welded to the side sheets. A mechanical stoker is provided and three Nicholson syphons are fitted. The trailing truck is of the usual single-axle type, with cast steel





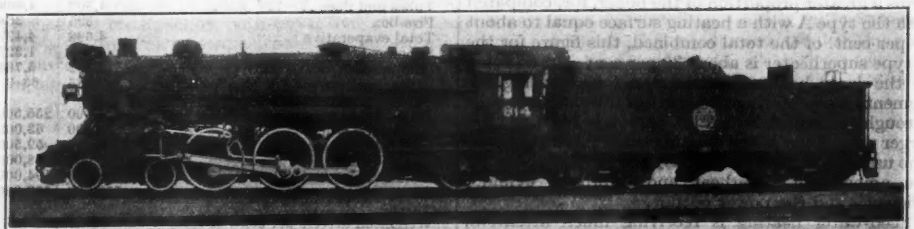


Fig. 3 (Above)—C.R. of N.J. 4-6-2 Type Locomotive
Fig. 4 (Centre)—B. and O. "President" Class 4-6-2 Type Locomotive
Fig. 5 (Below)—P.R. Class K. 5 4-6-2 Type Locomotive

framing. This design of truck is roughly triangular in plan and swings from a centre just behind the trailing axle, and the weight is taken at this point and also at the two hind corners under the rear of the fire-box. The springs are overhung and are compensated with those for the trailing coupled axle through compensating beams fulcrumed in the truck frames. In conformity with usual practice, the Westinghouse air brake acts on the coupled wheels and on the tender.

The Baltimore and Ohio (B. and O.) utilise the class of engine shown by the next illustration—Fig. 4—to work the more important express trains between Jersey City (New York) and Philadelphia, Washington, St. Louis, and Chicago. These locomotives, known as the "President" type, have been built by Baldwin to meet the requirements of Mr. G. H. Emerson, Chief of Motive Power, and are amongst the most powerful "Pacifics" running, having a tractive effort of 50,000 lb., rendered possible by the high axle loading allowable. The weight on the drivers is 201,000 lb., or 67,000 lb. per axle, equal to 29·9 long tons. The boiler is of the usual radial stayed round top type, and the fire-box has a combustion chamber, and two syphons, whilst two arch tubes support the arch. The length over the tube sheets is 19ft., and there are 212 2¼in. tubes, and forty 5½in. flues for the type A superheater. The water spacing round the foundation ring is of ample size, being 6in. at the front and 5in. at the sides and back. These engines are fired by a mechanical stoker, the operating engine being on the tender. The connecting-rod big ends have floating bushes, which are also applied to the side rod pins. The main driving axle journals are 12½in. by 13in., and those for the other coupled axles are 11in. by 13in. long. Walschaerts gear operates 14in. piston valves, having a 7in. full gear travel, 1⅛in. lap, and ¼in. inside clearance. A power reversing gear is fitted. A forced feed lubricator supplies oil to the cylinders, valves, stoker engine, and air brake compressor. The tenders have a one-piece cast steel under frame and carry 17½ tons of coal, and 11,000 gallons of water; they run on eight wheels, and a water scoop is applied, operated by a 12in. air cylinder.

It may here be mentioned that the B. and O., the C.R.R. of N.J., the Pennsylvania, and the New York Central, are the only lines using track troughs.

The New York and St. Louis fast trains weigh up to 940 tons, and the New York Washington expresses to about 526 tons behind the tender, the journey between the latter points of 226 miles being made in 4 h. 45 min. with eight stops.

The principal fast passenger services on the Pennsylvania (P.R.) are handled by engines of the "Pacific" type, the latest example of which is shown by the photograph reproduced in Fig. 5. This locomotive has been designed and built at Altoona Pa, by Mr. F. W. Hankins, Assistant Vice-president in charge of operation. In general, the design follows closely the "Pacific" Class K. 4's, first built in 1914 by the late Mr. J. T. Wallis, but some important modifications have been introduced, which bring them into line with modern practice. The boiler in respect to overall dimensions is the same as for the class "K. 4's" engines, and in construction also follows Altoona practice; but the material used is now a nickel steel for the barrel, and for the combined throat and bottom half of the rear barrel section. The material has a tensile strength of 75,000 lb., comparing with 60,000 lb. for carbon steel plates. The nickel content is specified to be within the limits of 2·75 to 3·25 per cent. The minimum ultimate tensile strength is 70,000 lb., and the yield point 0·5 of this figure.

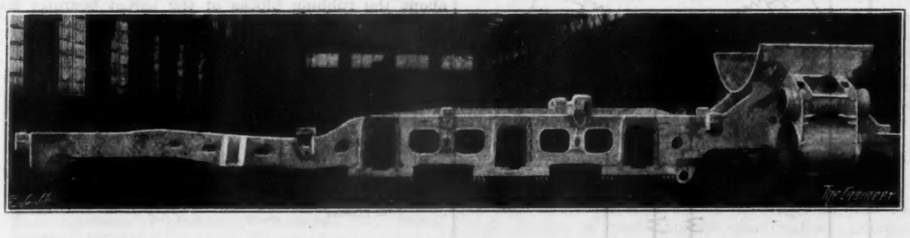


FIG. 6—CAST STEEL FRAME P.R. CLASS K 5 LOCOMOTIVE

The type A superheater of forty elements originally employed has given place to one of the type E with side headers. There are 170 3½in. flues, and ninety 2¼in. tubes, the length between the tube plates is 19ft., as for the earlier engines. The fire-box, with combustion chamber, is as before, and the grate area of 69·89 square feet is also retained. The changes made in the superheater and tubes have resulted in an increase in the total heating surface of 18·75 per cent., but the engine weight is increased by only 3·2 per cent. A further important modification is the use of a one-piece cast steel engine bed frame, which includes in one unit the framing, with all brackets, the cylinders with valve casings, and the saddle. This casting, an illustration of which is reproduced in Fig. 6, was made by the General Steel Castings Corporation. The cylinders are 27in. by 30in., and steam distribution is effected by 12in. piston valves set to give a full gear cut-off of 70 per cent., and operated by a light design of Walschaerts motion, which is controlled by a power reversing gear. The working steam pressure is 250 lb. per square inch. A feed-water heater is fitted. It is of the Worthington S type. The heater or mixing chamber is placed over the smoke-box behind the chimney, where it can be readily connected to the exhaust passages. Cold water is delivered to the mixing chamber by a rotary pump, driven by a steam turbine assembled complete as a unit, and fixed under the footplate. The hot feed is supplied to the boiler by a horizontal reciprocating pump mounted on the left-hand side of the engine at the front end. There is an automatic control for the feed obtained by slowing down the pump when the throttle is closed or only slightly open, as when "drifting." The feed water temperatures vary from 210 deg. to 230 deg. Fah., and higher temperatures are not desired, as the blast pipe and chimney have been specially designed with the idea of reducing back pressure on the pistons. The superheater delivers steam at temperatures of between 700 deg. and 750 deg. Fah. The motion parts are of light design and the crossheads of the multi-bearing pattern. The main rods have floating bushes at the crank pin ends, and the coupling rod pins are similarly fitted. The trailing truck is of the single-axle type standard on the Pennsylvania, and the weight, instead of being taken at the hind corners and pivot centre, is borne by the frame side members through combined sliding and spherical bearings abutting on the underside brackets cast on the main frames. The leading end of the truck frame connects through suitable links with the bearing springs for the trailing coupled axle. It will thus be seen that the truck framing serves also as a compensating connection. The spring compensation is continuous from the leading drivers to the trailing truck. The tenders are of novel design, especially so far as the under framing is concerned, which is a single steel casting, but without side sills. The draw gear pocket at each end are cast integral, and at the bogie centres side bearer arms project outwards to support the tank, which is strongly braced internally in such a manner as to transfer all strains to the centre member of the frame. The tender, which is fitted with a water scoop, carries 14,000 gallons of water, and 16 tons of coal; it runs on eight wheels and weighs, loaded, 245,000 lb.

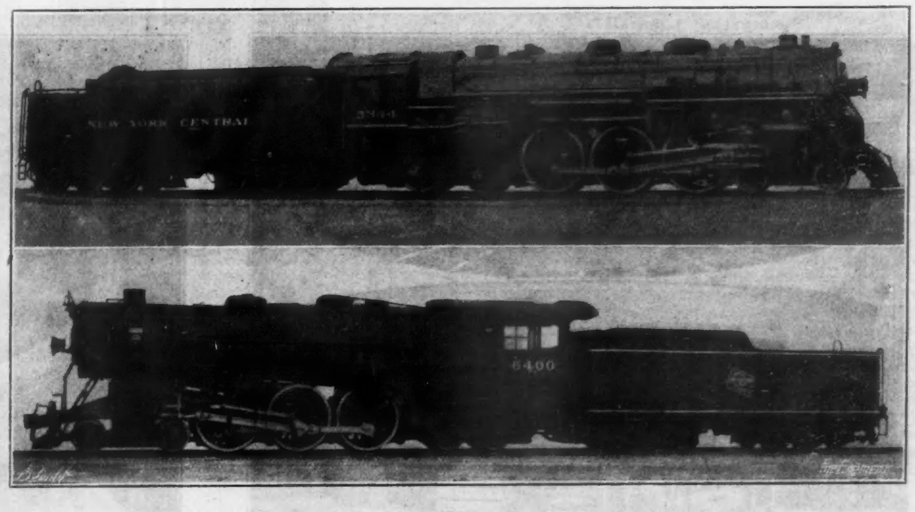


FIG. 7 (ABOVE)—N.Y.C. "HUDSON" TYPE 4-6-4 LOCOMOTIVE

FIG. 8 (BELOW)—C.M. ST. P. AND P. 4-6-4 TYPE LOCOMOTIVE

The following short tabulation compares the previous "K 4's" and the present "K 5" locomotives:—

Class.	K 4's.	K 5.
Cylinders	27 × 28	27 × 30
Drivers, dia., in.	80	80
Steam press.	205	250
Tractive effort, lb.	44,460	54,675
Total heating surface, sq. ft.	4,984	5,919
Grate area, sq. ft.	69·18	69·89
Weight on drivers, lb.	201,830	207,600
,, of engine	308,890	318,700

The New York Central (N.Y.C.) employs 4–6–4 engines of the "Hudson" type for working all important express services, and as this design has already been fully described by the writer in THE ENGINEER, extended reference will be unnecessary.*

The illustration Fig. 7 shows one of the latest of these locomotives to be put into traffic, which, like the others, has been built by the American Locomotive Company. This particular engine, No. 5344, is of interest, because it is equipped with Timkin roller bearings on the leading truck journals, the coupled axles and the tender trucks. The trailing four-wheeled truck has ordinary bearings. An exactly similar locomotive, No. 5343, is fitted in the same manner with S.K.F. bearings. Both were put into service late in 1931, and up to January 1st, 1933 No. 5344 had run 158,300 miles, and 5343 had covered 160,700 miles with satisfactory results. The trains hauled by engines of this type are amongst the heaviest and fastest in the country, and on many of the services the length of individual engine runs has been much extended. In this connection it will be of interest to note that the 20th Century Limited, running between New York and Chicago, a distance of 962 miles, is now operated by two engines only, compared with seven required in 1918. The steam locomotive replaces the electric at Harmon, 33 miles out of New York, and works through to Cleveland, 588 miles, where a change is made, the second engine running the remaining 341 miles to Chicago. The load to-day is fifteen Pullmans, as against ten in 1918.

The Chicago, Milwaukee, St Paul and Pacific (C.M. and St. P.) engine next illustrated—Fig. 8—represents one of fourteen passenger engines built by Baldwin and completed in 1930. From the particulars given in the table it will be gathered that these locomotives are of considerable power. In respect to boiler capacity they resemble the New York Central "Hudsons," but the tractive effort is rather greater, the cylinders being 1in. larger in diameter. The fire-box is fitted with a combustion chamber and there are three syphons, two in the box and one in the chamber. There are 182 3½in. flues for the E type superheater, and fifty-eight 2¼in. tubes, and over the tube sheets the length is 19ft. A mechanical stoker is provided. Boiler feed is taken through a Coffin feed-water heater, the heater portion of which is fitted into the upper part of the smoke-box just ahead of the chimney. These locomotives have a one-piece cast steel frame, complete with cylinders and saddle. Roller bearings are applied to the wheels for the trailing truck. The Baker gear operates 14in. piston valves and reversal is by means of a power control. The revolving, and 50 per cent. of the reciprocating, weights are balanced. The tender runs on twelve wheels, and carries 20 tons of coal and 15,000 gallons of water. The air brake acts on the tender; the air pressure is furnished by an 8½in. cross-compound compressor.

The (B. and A.) Boston and Albany 4–6–4 engines mentioned in the table are generally similar to the "Hudsons" of the N.Y.C., of which system the B. and A. is part. They differ in having smaller drivers and in respect to the working steam pressure, which is 250 lb. per square inch. The full gear cut-off is 65 per cent.

(To be continued.)

IN the course of a paper presented at a meeting of the American Institute of Mining and Metallurgical Engineers, held in New York recently, Mr. L. L. Wyman stated that (1) neither pure copper when oxidised, or deoxidised, nor tough-pitch copper containing up to 0·06 per cent. oxygen is embrittled by hydrogen at temperatures of 400 deg. Cent. or below after four hours' exposure, and that (2) (*a*) the rate of oxygen penetration into "pure" copper decreased markedly below 800 deg. Cent.; (*b*) the rate of hydrogen penetration into oxygen-bearing copper decreased markedly below 700 deg. Cent.

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* THE ENGINEER, November 16th, 23rd. and 30th, 1928.

A Large Hydro-Electric Generator.

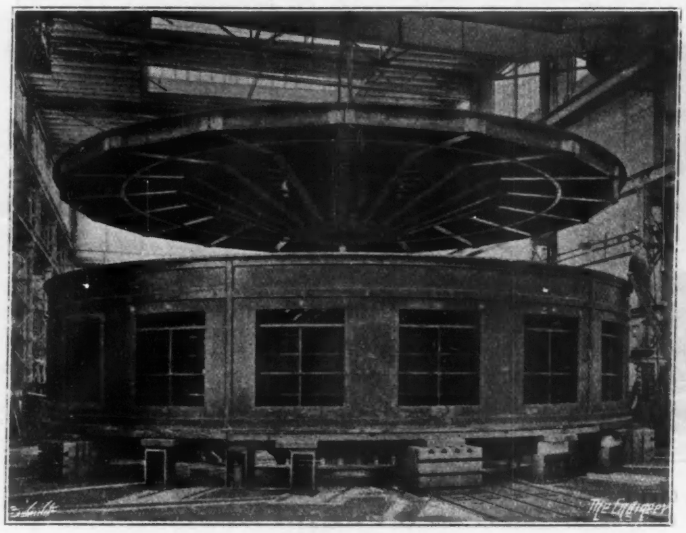

FIG. 1—STATOR WITH COVER RAISED

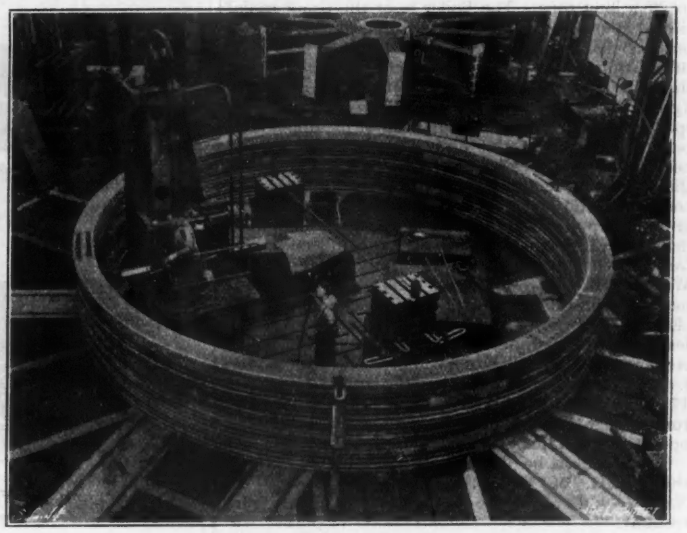

FIG. 2—ROTOR RINGS

SITUATED on the St. Louis Lake, about 25 miles west of Montreal, the Beauharnois hydro-electric power station of the Beauharnois Light, Heat and Power Company will have an ultimate capacity of 2 million horse-power. The station was described in THE ENGINEER of February 13th and 20th, 1931, and in October 30th of the same year. Constructional work was begun about 3½ years ago, with a view to providing an initial installation of fourteen main 50,000 horse-power units and two 7800 horse-power house sets, all of which will utilise the head amounting to 82ft. between the lakes St. Francis and St. Louis, connected by a channel 15·5 miles long. Ultimately, the complete equipment of the station will consist of forty-two 50,000 horse-power machines. Orders placed at present cover six 43,882 kVA, 25 cycle sets; four 46,625 kVA, 60-cycle sets, and the two 7800 horse-power units, which are also to generate at 60 cycles. All these machines are to be in service by October, 1937. One of the 43,882 kVA, 25-cycle generators, shown in Figs. 1 and 6, and on page 622, has been built by the Oerlikon Company, whilst the 53,000 horse-power Francis turbine for driving it is to be supplied by the Dominion Engineering Works, Ltd., of Lachine, Quebec. The following are the main particulars of the generator :—

Normal continuous output	43,882 kVA
Maximum continuous output	48,300 kVA
Power factor	0·85
Frequency	25 cycles
Pressure at terminals	13,200 volts
Test pressure according to the A.I.E.E.	30,000 volts
Normal speed	75 r.p.m.
Runaway speed	150 r.p.m.
Fly-wheel effect	49,200 tons × ft.^{2}
Temperature rise at normal load	99 deg. Fah.

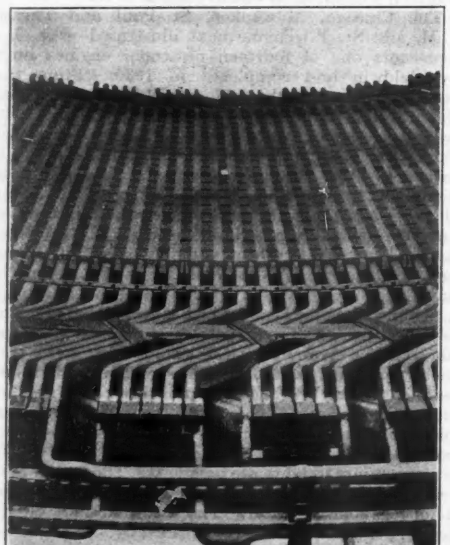

FIG. 3—PORTION OF STATOR WINDING

As the illustrations, Figs. 1 and 6, and those on page 622 indicate a fabricated construction has been adopted, the casing, which is 40ft. in diameter and 8·2ft. high, being made entirely of electrically welded steel plates. The stator, which, for reasons of transport, is composed of six parts, will be mounted on eighteen foundation plates evenly distributed around the circumference and grouted into the foundations, after the stator bore has been accurately centred relatively to the shaft. To facilitate this work, radial and vertical bolts are provided to permit of fine adjustments of the stator in all directions. Openings with suitable covers in the casing serve as outlets for the cooling air.

The laminated core plates are threaded on steel bolts welded to the casing webs, and also serve for pressing the plates together. Open slots accommodate the winding, Fig. 3, in two tiers with three conductors per slot, and arranged in several parallel circuits. Each conductor is subdivided into layers by insulating strips, and is twisted through 180 deg. in the middle of the stator. Mica tape serves for insulating the slot conductors. Special connecting lugs devised by the Oerlikon Company serve to connect the coils in a simple manner and to facilitate inspection. On either side, the ends of the coils are supported by a ring, which makes the winding capable of withstanding short-circuit stresses. Pipes and nozzles on the upper and lower sides of the winding serve to spray water on to the latter in the event of fire. As Fig. 4 shows, each phase is divided into similar circuits according to the split conductor arrangement, each being led at the beginning and at the end through a bar-type current transformer.

The current transformers S at the terminal end are connected to the relays of the differential protective gear for the outer circuit. Those at the neutral point end N are for the inner circuit, two generators working with one transformer. In the case of the inner circuit, the protective relays are set so that the differential current can rise to 10 per cent. of the normal current and to 25 per cent. in the case of the outer circuit.

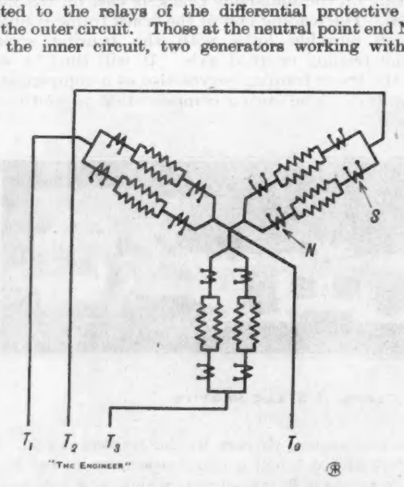

FIG. 4—ARRANGEMENT OF STATOR WINDINGS

Twelve thermo-couples are embedded in the stator windings at different points for the measurement of temperature. Leads from these couples, together with the secondary leads of the current transformers, are connected to a common terminal plate in the stator casing, and from this plate a multi-core cable runs to the control room. When completed the stator windings were subjected, in the manner shown in Fig. 5, to a test pressure of 30,000 volts for a period of one minute in the Oerlikon Company's works with satisfactory results. It was necessary, in order that the rotor, which is 33ft. 9in. in diameter, might be fully completed in the works without further adjustment on site, to subdivide the rim and spider into a fair number of parts. The pole cores are composed of stampings 1 mm. thick, riveted together and secured by keys and bolts to the rotor rings, shown in Fig. 2.

The poles are divided into ten groups, each containing four poles. Double coils composed of strip copper suitably insulated and subjected to a hydraulic pressure greater than that arising from centrifugal force, are mounted on the cores. The cast steel rotor rings, shown in Fig. 2, had to be divided into three parts in order to facilitate transport. In all there are six rings placed one above the other and separated by spaces for the passage of cooling air. Together with the poles, the weight of the rotor rings is 220 tons, which is carried by the ten arms of the rotor spider shown on page 622. The spider serves only for transmitting the torque and for carrying the weight, and does not have to deal with the centrifugal force of the poles and rings. The arms are bolted to a single-piece cast-steel hub, having a conical bore with a maximum diameter of 3ft. In view of the vertical load of 700 tons, the arrangement of the thrust bearing below the rotor is distinctly advantageous, for the reason that it permits of a considerable reduction of the supporting girder span. By means of a crane it is possible to raise the whole rotor without the shaft and without having to dismantle the thrust bearing when overhauling the machine, or when carrying out repairs. On the other hand, the thrust bearing can be removed without having to dismantle any part of the rotor, as all the bearing parts except the supporting ring are made in several pieces.

To enable the load to be taken off the thrust bearing blocks when the bearing is being dismantled, twenty-eight jacks operated with oil at a pressure of 2100 lb. per square inch are provided under the rotor rings, so that the whole of the rotating part of the generator, weighing 348 tons, can be raised. The oil under pressure is supplied by a double-acting hand pump. The jacks are also made to serve as brakes, the top of each jack being made in the form of a brake block with a brake lining. When used as brakes the jacks are worked with compressed air at a pressure of 210 lb. per square inch, the heat developed at the brakes being received, for the most part, by the lowest rotor ring.

A truck is provided for removing the parts of the thrust block laterally between the supporting girders. The ten segmental rubbing blocks of the thrust bearing are lined with white metal and carry the collars of the shaft, which is made in two pieces and has a diameter of 6ft. 10½in. Two stacks of copper tubes arranged in sections about the rubbing blocks of the thrust bearings serve for water cooling the oil supplied to the bearing. Below this bearing is the lower guide bearing in the supporting frame. The bearing brush has a bore of 3ft., and copper tubes for the cooling water are embedded in the white metal lining.

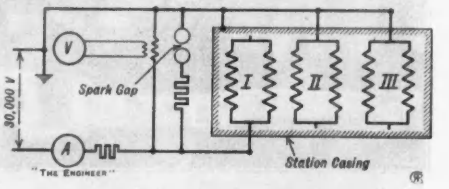

FIG. 5—CONNECTIONS FOR PRESSURE TEST

A separate exciter capable of supplying a maximum excitation current of 1080 ampères at 250 volts supplies current to the field winding through the two-part slip rings mounted on the shaft between the lower guide bearing and the shaft flange. From the slip rings the conductors for supplying the pole windings are led through the hollow shaft, which weighs 31 tons and is 23ft. 7in. long. The flange on the turbine side of the machine for coupling the generator to the turbine shaft is 4ft. 11in. in diameter.

Like the stator itself, the cover which carries the upper guide bearing is divided into a number of parts to facilitate transport. Warm air from all the sets will be discharged directly into the turbine room, and in order that this may not interfere with the proper supervision of the generators, all the instruments associated with the mechanical parts of the turbine and alternators are to be placed, together with the starting and regulating gear, at a level in the power station at which no inconvenience will be experienced. Instruments for supervising the mechanical operation of the generator will be entirely associated with the bearings. The thrust bearing and the two guide bearings each have separate lubricating and cooling systems. The instruments for supervising the latter will consist of distance thermometers, and water flow indicators, all mounted in a single case. Pipes will be provided for connecting up each bearing with an oil filter in order that the oil may be treated whilst the generator is at work. For erecting and dismantling the machines the power station is being equipped with two 160-ton cranes. The heaviest parts of the machine described are the complete upper generator cover, which weighs 28 tons; the complete stator, 174 tons; the rotor, without its shaft, 265 tons, and the lower bearings, with supporting girders and generator shaft, 95 tons. In order to handle any of these parts with one crane or with both, suitable equipment is being supplied.

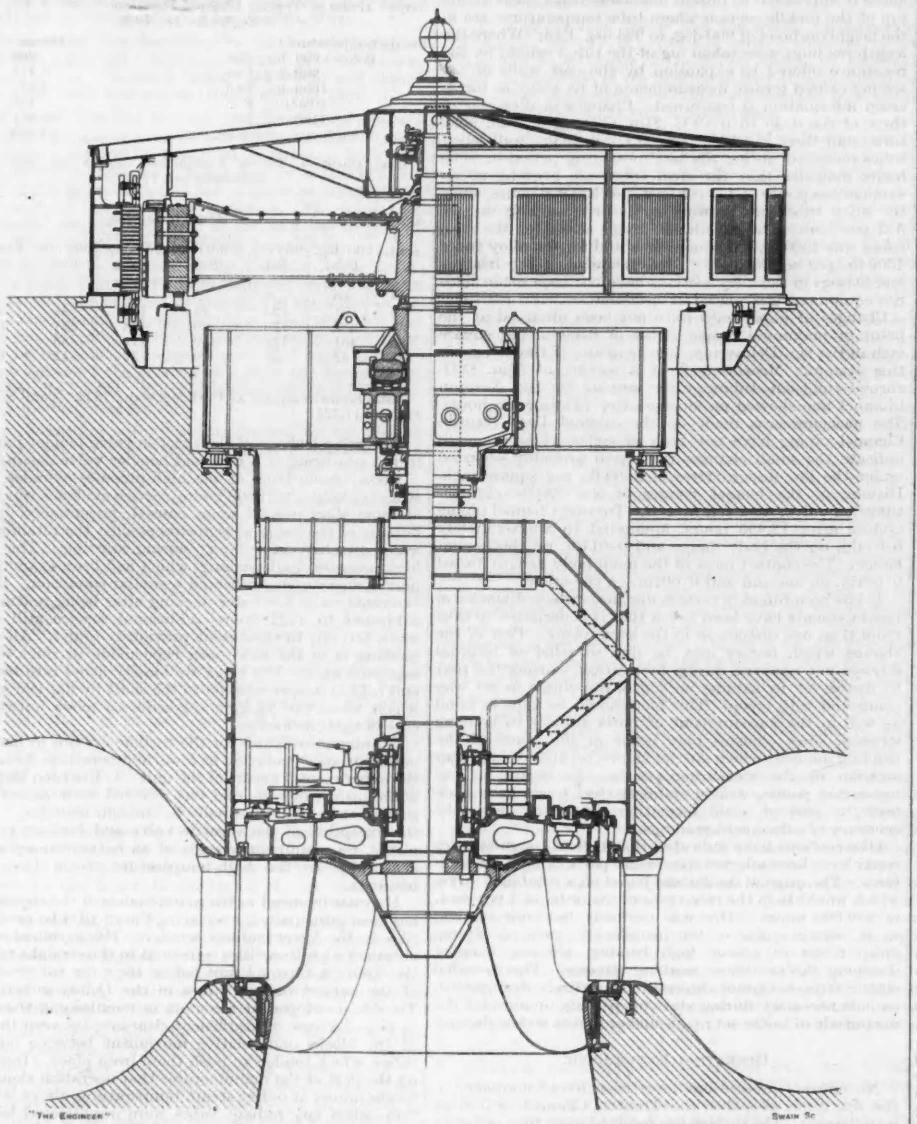

FIG. 6—VERTICAL SECTION AND ELEVATION OF HYDRO-ELECTRIC GENERATING SET

High-Temperature Steam Experience at Detroit.*

By P. W. THOMPSON, Chief Engineer of Power Plants, the Detroit Edison Company; and by R. M. VAN DUZER, Jun., Engineer, Production Department, the Detroit Edison Company.

Experience gained from equipment using steam as high as 1100 deg. Fah. in one of the power plants of the Detroit Edison Company since the fore part of 1929, leads the authors to believe that the design of steam generating plants using temperatures in the neighbourhood of 1000 deg. Fah. is entirely feasible provided users are prepared to specify the high-priced materials that experience so far dictates. A small oil-fired superheater, delivering 1100 deg. Fah. steam to a piping system has been in operation at the Trenton Channel plant since March, 1929. The information obtained in the operation of this equipment served as a basis of design for the separately fired superheater, piping and 10,000-kW turbine generator which was placed in operation with 1000 deg. Fah. steam the latter part of 1931 at Delray Power-house No. 3.

The principal trouble with the two installations has been encountered at Trenton Channel and has been caused by the leakage at flanged pipe joints. The use of better bolting material and changes in flange design have materially improved conditions. Replacement of a cracked desuperheater casting was necessary in the Trenton Channel set-up, and a new turbine throttle valve of improved design has been purchased to correct recurring leakage at the bonnet flange at Delray. With these exceptions no troubles of a serious nature have been experienced.

Examinations of the austenitic 18 per cent. chrome, 8 per cent nickel alloy which was used in the construction of the Trenton Channel superheater and piping system show that this material has deteriorated in service, due, probably, to precipitation of chromium carbides along the grain boundaries. There is, however, no evidence thus far of intercrystalline corrosion and no such serious reduction in physical properties as would lead to rejection of this material for steam service in the 1000 deg. to 1100 deg. Fah. range. Tests of other steels belonging to the low alloy class have disclosed no marked change in their properties. Since the time these two experiments were undertaken there has become available much more information concerning the behaviour of alloy steels and, this, together with advances in the art of manufacture, has made the selection of stable alloys for this class of equipment a simple matter for the designer.

Operation with high-temperature steam has presented no problems of an unusual nature. The equipment, particularly the turbine, has been given close attention because of its experimental nature. The turbine at the present time, however, is receiving only the same care as other equipment in the Delray Power-house.

This paper is primarily concerned with a discussion of the reasons for the selection of the materials that were used, results of metallurgical examination, operating features, and troubles that have been experienced and remedies applied.

Description of Equipment.

The Trenton Channel equipment consists of an oil-fired superheater supplied with 400 lb., 700 deg. Fah. steam from the station header. Approximately 65ft. of 5½in. O.D. tubing conducts the high-temperature steam to a desuperheater where the temperature is reduced before passing to one of the house service turbines. The superheater, supplied by the Babcock and Wilcox Company, is of the radiant type, containing 153 square feet of refractory covered heating surface, and is capable of adding 400 deg. of superheat to 6000 lb. of steam per hour from an initial temperature of 700 deg. Fah. The tubes which comprise the rear and side walls of the unit are covered with refractory blocks cemented to welded-on lugs on the tubes to prevent direct exposure to the radiant heat.

The Delray installation consists of an oil-fired superheater, interconnecting high-temperature piping, a 10,000-kW British Thomson-Houston turbine generator, condensing equipment, and auxiliary pumps and heaters, together with the piping necessary to connect the turbine flow circuit into the existing plant systems. The equipment occupies a space provided for a future boiler and is compactly arranged.

The superheater contains 3957 square feet of surface arranged in three sections; a top convection section, a middle semi-convection-radiant portion, and a lower radiant section which encloses the combustion chamber on the two sides and bottom. The tubes in the lower section were provided with the same type of refractory covering as used in the Trenton Channel superheater. The unit was designed to superheat 90,000 lb. of steam per hour from 700 deg. to 1100 deg. Fah., at a pressure of 455 lb. per square inch, although the ordinary operating pressure does not exceed 400 lb.

The turbine is a two-cylinder, single-shaft, 3600 r.p.m., straight impulse type unit containing nine stages in the high-pressure cylinder and eleven stages in the low-pressure portion. It was designed for steam at 365 lb. per square inch gauge, 1000 deg. Fah., exhausting to 1in. Hg. absolute. Steam is extracted at the ninth, fourteenth, and seventeenth stages for feed water heating. Except for the double casing construction, and the external supply of saturated steam which is supplied to the high-pressure shaft packing to cool the shaft and bearing, the general design of the turbine differs little from impulse turbines manufactured in this country. The generator, rated at 10,000 kW at 0·8 power factor and 4800 volts and equipped with two direct-connected exciters and a closed ventilation system, is of standard design. The condensing equipment and auxiliaries are identical with those used for the 4000-kW D.C. auxiliary turbine generators in the power-house.

Material Selections.

At the time the Trenton Channel equipment was being designed in 1927 the austenitic 18 per cent. chrome, 8 per cent. nickel alloy was being offered as the ideal material for equipment operating at elevated temperatures. Various investigators in this country and abroad had established its high physical properties and resistance to creep at temperatures in the range from 1000 deg. to 1100 deg. Fah. The principal objections to its use were the high cost and difficulties of fabricating in either the cast or wrought form.

Several different classes of so-called low-alloy steels were installed in both installations in an attempt to learn as much as possible regarding the behaviour of various alloys under the action of the high-temperature steam and at the same time find materials other than the expensive austenitic group. Aside from the saving in material cost involved in using these cheaper alloys, they are more readily fabricated into sound castings and tubing. This was illustrated by the delay and expense involved in the drawing and fabrication of the Delray superheater tubes and the pouring of the outlet fittings. It was impossible for the maker to draw and bend tubes long enough for the lower section of the superheater from the KA2B material. This section was finally completed by flash welding shorter tubes together. It was also necessary to recast the outlet fittings before sound ones were obtained.

A few tubes of medium and high-carbon calorised steel were installed in the Trenton Channel superheater to determine the degree of protection secured with aluminium coating. After the first installation of this material, 0·35 C steel tubes coated with aluminium were installed in the middle section of the Delray superheater, together with a like number of tubes coated with 18–8 and 12–14 per cent. Cr stainless steel applied with a Schoop metal spray gun.

The selection of materials for the turbine was left entirely in the hands of the turbine builder. They, working with the Brown-Firth laboratories, selected as the result of time yield tests a nickel-chromium-molybdenum alloy for the turbine throttle valve, the high-pressure shaft packing case, the inner and outer high-pressure cylinders, and the forged rotor. The time yield test on this steel at 1000 deg. Fah. showed less than a 0·5 per cent. extension during the first twenty-four hours at a stress of 5600 lb. per square inch, and no further extension during the next twenty-four hours. A maximum design stress of 6000 lb. per square inch accordingly was used in the turbine design. The original interstage diaphragms were cast from the same material, but, due to the imperfect castings obtained, these were replaced with built-up diaphragms made from a 0·40 per cent. carbon steel before operation with 1000 deg. Fah. steam. The turbine nozzle partitions and wheel blading, with the exception of the first stage buckets, were made from a 0·25 per cent C, 14 per cent. Cr, stainless steel. Hecla ATV1 containing 0·47 per cent. C, 11·8 per cent. Cr, and 36·3 per cent. Ni was used for the first-stage blading. All of the shaft packing was made from forged modified monel. The interstage packing was later changed to a stainless steel at the time the original diaphragms were replaced. Nothing unusual in the way of materials was used in the low-pressure element.

With the exception of several parts, the careful attention that was given to the selection of the materials described has so far resulted in trouble-free operation.

Metallurgical Examinations.

Results of both physical and microscopic examinations made on various materials from the two installations have shown evidence of slight changes. In no case, however, have these changes, loss in strength, or tendency toward embrittlement, progressed to such an extent that any consideration has been given to replacement of parts. It is entirely possible that the changes which have been observed will progress at a much slower rate than has occurred during the initial period of operation.

The surface of the calorised and sprayed Delray tubes is apparently in good condition except in several spots where a coarse granular appearance indicates a brittle condition. The tubes now have become coated with a $\frac{1}{16}$in. layer of slag which protects the coating from attack. The development now being made to produce a more ductile aluminium coating and its application to low alloys possessing good creep properties offers possibilities for the adoption of this class of material for high-temperature equipment.

Pipe Joint Experience.

Troubles encountered with bolted pipe joints have been many and varied. In the authors' opinion, it is doubtful whether with present materials bolted joints can be designed to give the same trouble-free operation at temperatures of 1000 deg. to 1100 deg. Fah. that has been experienced with present designs at 700 deg. to 750 deg. Fah. From experience gained, however, with the original joints at Trenton Channel, it has been possible to construct two joints that have now been in service for over 16,000 hours at steam temperatures above 1000 deg. Fah. without attention. Full strength welded joints appear to be the answer to the high-temperature jointing problem, although there is much to be learned regarding the behaviour of weld metal under stress at high temperature and the weldability of desirable high-temperature alloys.

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* Abstracted from a paper presented at the annual meeting of the A.S.M.E., December 4th–8th, 1933.

It was rather fortunate, in one respect, that the original joints at Trenton Channel were not made heavier than the 600-lb. A.S.A. flange standard, as troubles were soon encountered which led to improvements in design. Some of the difficulties probably would not have been anticipated in the turbine installation at Delray had these joints been made more substantial. This original design led to the use of various joints which fall roughly into five classes.

Two types of stress, aside from stress due to internal pressure and bending moment imposed by change in position of a line, appear to cause most of the difficulty in high-temperature bolted joints. These are thermal stress caused by the temperature differential between the inside and outside of the joint and differences in coefficient of expansion of the joint materials, and creep stress caused by the plastic condition. In order to eliminate the thermal stresses, so-called temperature compensated joints were tried. These consisted of joints using 18–8 bolts and having spacers between the flange and nut of a material similar to Invar. The bolt and spacer lengths were so selected that any tendency to pick up or lose load was compensated for by the difference in coefficient of expansion. These joints failed, due to the rather high stresses selected and failure to consider the plastic phase at the operating temperature.

The second class of joints used were similar to the original joints with materially increased flange and bolt dimensions. Two 5in. joints in the Trenton Channel line, made up with the bolt stress limited to 10,000 lb. per square inch, have been in service over 16,000 hours. These are Van Stone type with serrated facing, KA2* flanges, steel No. 1 bolting material and $\frac{1}{32}$in. plain monel gaskets. The 900 lb. flanges in one joint were increased to 3⅜in., while the 1500 lb. flanges in the second joints were made 4⅝in. in thickness. All of the bolted joints in the Delray line, with the exception of the joints on either side of the superheater outlet valve, were made to either the 900 lb. or the 1500 lb. A.S.A. standard. Leaks which occurred in two 8in., 1500 lb. joints after 6795 hours of service were due to plastic deformation of the gasket faces rather than to dishing of the flanges or creep of the bolts.

Full strength mechanically reinforced welded joints are in service in both installations. The mechanical reinforcement, consisting of collars over three Trenton Channel joints and backing up flanges on the Delray joints, was added to prevent pulling apart should the 18–8 weld metal ever disintegrate due to inter-granular corrosion at the fusion zone. Additional time is needed to determine definitely whether such precaution is or is not necessary in 18–8 welds. It would appear from examination of the fusion zone of welding on the 18–8 tube removed from the Trenton Channel superheater that the region affected by welding does not undergo any more rapid change than the parent metal; at least when under no stress. This particular welding was used to fasten lugs to hold the tube protecting tiles. These joints have given no trouble.

Another class of joint in service, embracing the Sargol and Sarlun, is seal welded. The original Trenton Channel joints were provided with Sarlun welding lips, two of which were welded after trouble was experienced maintaining a tight-gasketed joint. During the 17,236 hours of service it has been necessary twice to repair cracks which developed in each joint as a result of bolt elongation. The modified Sargol type joints, used in the interconnecting and outlet piping of the Delray superheater, where the steam temperature varies from 850 deg. to 1000 deg. Fah., have given no trouble.

The high stresses encountered in the Trenton Channel joints and a desire to obtain satisfactory joints for the 600 lb. flanges of the valve at the superheater outlet led to the design of the hairpin type spring joint. The first of these joints installed at Trenton Channel consisted of springs, of hairpin shape, placed between the flange and one nut on each bolt. The springs were designed to maintain a unit gasket pressure of ten times the S.S.P. during the warming and cooling of the joint by compensating for the unequal expansion between flanges and bolts. The bolts were stressed to approximately 10,000 lb. per square inch and the outer end of the spring was stressed to about 17,000 lb. per square inch. The joint was remade after 1532 hours' service and has since remained tight for nearly 15,000 hours. The temperature at the highly stressed outer portion of the spring does not exceed 600 deg. Fah. with 1100 deg. Fah. steam in the line. The two Delray joints, which were designed with a maximum spring stress of 60,000 lb. per square inch, leak when being placed in service, due to water accumulation. They tighten up, however, when this water is evaporated. This design is not recommended because of the spring weight and cost. Its use was desirable in our case to prevent overstressing the valve flanges which were ordered to the 600 lb. standard before sufficient experience was obtained at Trenton Channel with this standard.

CREEP.

Troubles due to growth or creep of parts, with the exception of the difficulties encountered with the 600 lb. standard pipe joints, have been confined almost wholly to the turbine throttle valve. Excessive growth of the lower ends of the calorised superheater tubes at Trenton Channel caused their removal before failure occurred. Creep of other parts has been measured, but in no case where changes have been observed is the creep occurring at an alarming rate.

The throttle valve trouble has been caused by dishing of the bonnet joint flanges, with the result that it has been impossible to maintain a tight joint. The body itself has also exhibited changes amounting to creep rates as high as 3·5 per cent. per 100,000 hours based on measurements made during the last 6083 hours of operation. This growth caused slight binding of the main disc on one occasion.

Measurements of parts of the turbine, other than initial readings, have not been obtained except in the case of the valve chest, where a special measuring device was provided by the makers to determine the overall change in length. The changes measured have been insignificant. The last reading obtained at this location showed a slight decrease which would indicate warping. It is probable that excessive changes have not occurred in the turbine. The running characteristics have not changed and leaks have not been experienced at any of the bolted joints on the high-pressure cylinder.

The periodic measurements that have been made of the tubes in the Delray superheater are of rather doubtful value. Two types of readings are being taken from stainless steel measuring points; diameters with micrometers and length measurements with a special 20in. micrometer trammel. The close grouping of the tubes has made it impossible to obtain diameters other than at the top of the middle section where tube temperatures are in the neighbourhood of 900 deg. to 925 deg. Fah. Where the length readings were taken sag of the tubes caused by the resistance offered to expansion by the cast walls of the setting caused erratic measurements of no value as far as creep information is concerned. Changes in diameter of three of the 0·30 to 0·40 C, 2½in. O.D., $\frac{7}{16}$in. wall, steel tubes and three KA2B*, 2¼in. O.D., 0·203in. wall, alloy tubes observed during the last measuring period of 5005 hours indicates that the steel tubes are growing at an average creep rate of 4·4 per cent. per 100,000 hours, while the alloy tubes are growing at a corresponding rate of 5·3 per cent. The calculated design stress for the steel tubes was 2000 lb. per square inch and for the alloy tubes 4300 lb. per square inch. Measurements of the headers and fittings in the alloy sections have not been made since the equipment was placed in operation.

Changes of importance have not been observed at the point of maximum design stress of 6400 lb. per square inch in the 8in. Delray pipe line or in any of the fittings in this system. Measurement of a section of 5½in. O.D. chrome-tungsten tubing after service in the Trenton Channel line showed no change after 7465 service hours. The measurements made on the original 18–8 Trenton Channel piping have not been of sufficient accuracy to indicate the small changes that have probably occurred under the low design stress of 3200 lb. per square inch. Dishing of the bonnet flanges of the 600 lb. chrome-tungsten valve, removed from the Trenton Channel piping system after 12,995 hours, amounted to approximately 0·014in. on the body flange and 0·011in. on the bonnet flange. The contact faces of the main body flanges dished 0·004in. on one end and 0·007in. on the other.

It has been found in certain instances where diametrical measurements have been taken that it is desirable to take more than one dimension in the same plane. Part of the change which occurs may be due to relief of internal stresses not removed during fabrication, causing the part to distort or to assume an out-of-roundness in no way connected with creep. This fact should be kept in mind as well in the measurement of parts subject to bending stresses, since changes may occur in the plane of the bending moment which are not shown because of improper location of the measuring points. In regard to the measuring points, welded stainless steel beads have been used to prevent scale formation detracting from the accuracy of subsequent readings.

Observations have indicated that higher design stresses could have been selected for certain parts of both installations. The original design was based on a combined stress which would keep the creep rate of the order of 1 per cent. in 100,000 hours. This was probably too conservative, as in certain parts of the installation, such as piping, creep tends to relieve high bending stresses, thereby dropping the combined working stresses. The so-called elastic stresses cannot, however, be entirely disregarded, as it is necessary during start-up periods to consider the magnitude of forces set up at anchor points and at flanges.

OPERATING EXPERIENCE.

No unusual precautions have been found necessary in the operation of either the Trenton Channel or Delray installations. The turbine has received more than ordinary attention due primarily to the experimental nature of the unit rather than from any hazard connected with the use of 1000 deg. Fah. steam. Major troubles have not occurred with either the turbine or the superheater. Experience with the Trenton Channel superheater and piping system has had to do more with pipe joint troubles already mentioned in some detail. The following remarks regarding operation, therefore, are confined to the Delray apparatus.

Operating a turbine with 1000 deg. Fah. steam is little different from operating with lower superheat. The present starting cycle used in placing the installation in operation consists in starting with 700 deg. to 750 deg. Fah. steam and applying 30 per cent. load to the turbine before the temperature is increased. The same procedure, in the reverse order, is followed in taking the unit out of service. It is believed that the use of higher temperature steam would tend to complicate the starting cycle because of large temperature differences which would exist in the turbine. It is the authors' opinion that units which may in the future be built for 1000 deg. Fah. operation should be provided with either a low-temperature source of starting steam or a desuperheater in the turbine lead to prevent the occurrence of severe high thermal stresses during the starting period.

A clearance indicator mounted at the front end of the high-pressure cylinder showing the movement of the rotor relative to the casing has been used as a guide in determining a safe rate for changing load or steam temperature. The forged rotor, a smaller metal mass than the casing and in more intimate contact with the steam, is more responsive to temperature changes. Its movement is watched, therefore, to prevent going below a safe minimum axial clearance of 0·010in. to 0·014in. on the leading edge of the fifth wheel. No maximum rates of load or temperature change have been determined, but load has been applied at the rate of 1000 kW per minute from 30 per cent. to full load without producing vibration or a clearance change exceeding 0·045in. Normally load is changed at a rate of 1000 kW per 3 to 4 minutes and temperature is changed at a rate of 100 deg. per hour. This last rate is an arbitrary one and might be exceeded without difficulty. Attention should be given to this detail of running clearance in any turbine designed to operate at high temperature or under rapidly fluctuating load conditions.

During the initial period of operation the steam temperature was increased in increments of 25 deg. to 50 deg. above 900 deg. Fah., allowing the unit to operate approximately one week at each temperature until 1000 deg. Fah. was reached. During this period of operation growth of the throttle valve packing sleeve occurred, causing the stem to bind. The original semi-steel bushing was replaced with one having a nitrided surface and no evidence of growth has since been observed. Similar bushings in the five control valves were also renewed with nitrided parts as a precaution.

TABLE.—*Service History of the Trenton Channel and Delray Installations.*

Service Hours of Trenton Channel Installation, March 4th, 1929, to September 1st, 1933.

Steam temperature.	Hours.
Below 900 deg. Fah.	360
900 deg. Fah.	1,471
1000 deg. Fah.	4,420
1050 deg. Fah.	438
1100 deg. Fah.	16,311
Total hours in service	23,000

Load Duration, Delray Installation, October 1st, 1930, to September 1st, 1933.

Load, per cent.	Hours in service.					
	700 deg. Fah.	800 deg. Fah.	850 deg. Fah.	900 deg. Fah.	950 deg. Fah.	1000 deg. Fah.
20	40	6	2	3	—	3
40	191	123	28	106	41	3545
60	327	170	60	438	377	1959
80	404	139	480	211	85	582
100	62	38	19	37	12	1743

Total hours in service at 1000 deg. Fah., 7832. Total hours in service, 11,231.

Recurring leakage of the throttle valve bonnet joint led to the procuring of a new and heavier valve casting.

Upon examination of the high-pressure cylinder inter-stage packing after 3809 hours' service evidence was found of more than normal wear, caused, presumably, by the binding of the packing segments against the retaining pin which resulted in rubbing during starting. The outer high-pressure shaft packing, which had been examined on previous occasions, indicated a similar condition. Recent examination of the outer packing after being refitted and subjected to 7422 hours' additional service still shows wear, but not to the extent previously found. All of the packing is of the saw-tooth type made in rings of four segments each. The rings are loosely fitted into tee slots and held in proper relation to the shaft by flat leaf springs which allow the packing segments to move outward in case of shaft deflection.

Maintenance figures for the turbine are not in line with other turbines operating at lower temperatures because of the experimental nature of the unit. It has been inspected at frequent intervals and has received more attention in general than would normally be thought necessary. With the exception of the throttle valve and bushing replacements, no maintenance costs of an extraordinary nature chargeable to the high-temperature steam have been incurred.

Expense incurred in the maintenance of the superheater has been principally for replacing the small tube-protecting tiles in the lower radiant section. The excellent results obtained with these tiles cemented to the straight tubes in the Trenton Channel unit led to their use for protection of the curved radiant tubes in the Delray superheater. Trouble developed at the start in maintaining these tiles in place because of insufficient clearance between the ends of the blocks and relative movement between adjacent tubes, which tended to push them from place. Insistence on the part of the manufacturer that operation should not be continued at outlet steam temperatures above 900 deg. Fah. when any radiant tubes were unprotected led to a change in the method of insulating the back of the tubes. Tie bars, holding the tubes in groups of twelve, were added to reduce the relative movement of adjacent tubes, and the tile shape was altered slightly to provide greater clearance between tiles. These changes have materially improved the service continuity of the refractory lining. At the present time, should a tile drop out of place during operation, the temperature is not lowered and the tube is allowed to remain bare until the next shut down.

Water collecting in the U-shaped tubes forming the furnace bottom has complicated the starting process somewhat. The procedure is to admit no steam to the superheater until after the fire has been started and temperatures of about 300 deg. Fah. are indicated on the tube thermo-couples located at the bottom of three arbitrarily selected tubes. The power-operated relief valve at the outlet is then opened to provide a sufficient circulation of steam to carry out any remaining water. Conditions are then satisfactory for admitting steam to the turbine for starting.

The Trenton Channel installation has now been operated for a total of 23,000 hours and the Delray equipment has been operated for 11,231 hours up to September, 1933. The hours of operation at various temperatures are shown in detail in the table.

CONCLUDING COMMENT.

In summing up the experience recorded to date with the two high-temperature installations, the information that has been gained on various types of construction and the results of metallurgical examinations would indicate that the use of steam equipment at temperatures as high a 1000 deg. Fah. is entirely feasible. It is safe to say that a plant could now be built to operate on 1000 deg. Fah. steam and that reliable service could be expected. Although the authors may have appeared to stress the shortcomings and difficulties, it is not their intention to convey the idea that these are of a serious nature or in excess of the general run of troubles to be expected with any equipment of an entirely new and untried design.

It is not the purpose of this paper to present the economics of such a choice of steam conditions. In the authors' opinion it is doubtful whether such a selection could be justified if high-temperature resisting materials now available were used. Further metallurgical research may produce such materials at a much lower cost which will in the future give economic justification to the use of 1000 deg. Fah. steam.

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* 85,000 lb. tensile with 40 per cent. elongation in 2in.

* 90,000 lb. tensile with 40 per cent. elongation in 2in.

Railway and Road Matters.

The new general secretary of the National Union of Railwaymen, to succeed Mr. C. T. Cramp, who died suddenly on July 14th, will be the late assistant secretary, Mr. J. Marchbank.

It is announced that Mr. Arthur R. Cooper, the chief engineer to the London Passenger Transport Board and President of the Permanent Way Institute, has consented to remain in the latter office for another year.

It is stated that the Southern Railway Company's all-Pullman train, the "Southern Belle," is to be known in future as the "Brighton Belle." We would add that this particular train first ran on December 10th, 1888.

When the Railway Returns for 1932 give the percentage of steam locomotives in use out of the number available, those, in a serviceable condition, withdrawn from service and stored is excluded. Those engines numbered at the end of the year 1135, and the number in use was 89·30 per cent. of the remainder available. The engine-hours in traffic per weekday were 11·68, and the engine-miles run per weekday were 102·99 per locomotive.

In asking the sanction of the Railway Rates Tribunal to the Great Western Railway Company reducing its rates for the carriage of wood to one-fifth of the standard rate, Mr. Cole Deacon, for the company, said that this was a very heavy reduction, but it was necessary if the railway was to be able to compete with the road companies, which collected the goods direct from the farms in large lorries fully loaded. The application, which is for a period of six months, was granted.

In connection with the presentation by the Brighton Corporation to the Southern Railway company's s.s. "Brighton," of a painting by Mr. Leslie Carr, it was stated that that boat, having a speed of 25 knots, was estimated to be the fastest merchant vessel of her size afloat. As related in our Seven-Day Journal, of April 14th last, this vessel, which was placed in the Newhaven-Dieppe service on the 10th of that month, is the fifth of that name to be employed in the service of the Southern Railway and its predecessor, the London, Brighton and South Coast.

The Southern Railway Company has just placed an order with William Denny and Brothers, of Dumbarton, for a paddle steamer for the Portsmouth-Ryde service. She will be the sixth new vessel placed on the service during the last ten years, the others being the "Shanklin" in 1924, the "Merstone" and "Portsdown" in 1928, and the "Southsea" and "Whippingham" in 1930. The new boat will have a speed of 14½ knots, and will be licensed to carry about 900 passengers. She will have triple-expansion engines, and will be ready to take her place on the service next July.

A rather suggestive question was addressed to the Minister of Transport on December 11th. Sir William Davison was wishful to know when the rolling stock and motors of the Inner Circle trains of the Metropolitan Railway were last inspected. The answer was that the Minister had no power to make any such inspection, but the annual report of the railway company included a certificate to be signed by the chief mechanical engineer to the effect that the rolling stock had been maintained in good working condition. That certificate appeared in the Metropolitan Railway report for 1932.

A deputation from the Ilford and District Railway Users' Association waited upon Lord Ashfield and the London Passenger Transport Board on Thursday, December 7th, as to the construction of a tube railway to Ilford. The deputation was told that the Board recognised the seriousness of the position, and had made a careful study of the problem in collaboration with the L. and N.E.R. Company. As far as the Board could estimate, there was not the slightest possibility of the services being self-supporting. Lord Ashfield added that the Board had been asked by the Minister of Transport to report on the subject, and the report would be ready shortly.

The fatal collision of December 6th, at Altrincham, mentioned herein on the 15th, was inquired into, on behalf of the Ministry of Transport, by Colonel Trench. As we read the evidence in the *Manchester Guardian*, it would seem that after the first train had arrived in No. 2 platform, the signalman in the South box opened the points for the train to set back into a siding. Hearing, that man said, two "pops" on the whistle, he concluded, in the dense fog that prevailed, that the movement was completed and lowered the signals for the second train. The standing train had not, however, moved, and the collision resulted. Answering a question by the N.U.R. representative, the signalman said that had the platform line been track circuited, the collision could not have occurred.

The Medway Canal was authorised in 1792 in order to give direct communication by water between the Medway at Rochester and the Thames at Gravesend and so avoid the longer journey by the Nore. A short time after railway communication was established in this country the Gravesend and Rochester Railway and Canal Company was formed. It was to convert the canal into a railway. The South-Eastern Railway Company subsequently obtained a lease of the undertaking, and in 1845 Parliament confirmed that transaction and sanctioned an improved scheme. Railway communication between the two points was established on August 23rd, 1847, but it was not until July 30th, 1849, that the North Kent line at Greenwich was extended to Gravesend, and there was through rail communication between London and Rochester *viâ* Gravesend. The canal was only filled in as between Rochester and Higham and there still remained 4½ miles of canal thence to Gravesend. The Railway Returns for 1932 show that the canal carried 36,243 tons of traffic during last year, which, however, brought in only £247, to which sum had to be added £1776 for canal dock dues and £195 for rents. Against this was an expenditure of £1560. The canal is now the property of the Southern Railway Company, which is seeking Parliamentary powers to transfer that portion which lies in the borough of Gravesend to the Gravesend Corporation and to abandon the remainder of the canal.

Notes and Memoranda.

The car-miles travelled by the trams of Great Britain decreased during the year by 4·69 per cent., while the passenger journeys decreased by 6·40 per cent.

The Smithfield-street Bridge in Pittsburg was built in 1882, and was considered to be too weak for modern traffic, but it has been given a new lease of life by putting in an aluminium floor.

In a paper read before the Institution of Engineers, Australia, Mr. F. H. Harrison, works manager of the Islington repair shops of the South Australian Railways, said that the use of the acetylene blow-pipe in the repair of copper locomotive fire-boxes had resulted in a saving to the railway of £25,000 in three years.

The issue of the *Journal of Scientific Instruments* for November contains an illustrated article on soldering and brazing by A. S. Newman and Dr. R. S. Clay, which will be found most useful by workers in scientific laboratories. It describes the conditions under which soft and hard soldering can be carried out most successfully, the best fluxes to use, and the proper way to apply them and the solder. Special methods for tubes and for manganin wires are described, and handy forms of burners, clamps, and cutting tools are shown.

Investigations at the Pittsfield works of the General Electric Company have indicated that a lightning rod not only protects the structure upon which it is erected, but also a considerable area around it. A low lightning rod is particularly effective in this respect in proportion to its height. A rod 100ft. high will protect a flat area surrounding it for a distance of approximately 400ft. from the base of the rod when the storm cloud is not lower than 1000ft. A 500ft. rod will protect over a radius of approximately 650ft. and a 1000ft. rod over a radius of at least 1000ft., assuming a flat area in each case.

An apparatus for testing the soundness of welded joints is described in *A. E. G. Progress*, No. 3, 1933, as follows :—The welded seam is magnetised by two permanent magnets, magnetically linked by an iron core. If defective spots are present the field is distorted. The course of the magnetic field is explored by a probing device consisting of an amplifier and headphones. A search coil located in the head of the probing device is made to vibrate by means of a magnet energised from the supply voltage. When the device is glided slowly over the welded seam, any alteration in the loudness or tone of the sound produced shows that defects are present. The seam can be explored rapidly, and after a little experience the kind of noise produced is sufficient to diagnose the nature of the fault.

An interesting application of a mercury switch has been made at the plant of an American cement company to control the feed to 10ft. conical mills in the raw grinding plant. These mills, which operate in a closed circuit with the air separators of the plant, are controlled by inserting a depression gate in the oversize chute of the air separator. The gate is connected by a linkage to a mercury switch which operates a revolving gate in the chute from the feed bin to the main conveyor. As the feed to the mill increases or decreases the depression gate is raised or lowered according to the quantity of material flowing through the chute, the change in position thus making or breaking the contact of the mercury switch. The latter energises or de-energises the solenoid on the revolving gate, which locks or releases that gate, controlling the flow from the feed bin to the conveyor.

Reports have appeared, says *The Iron Age*, to the effect that Russia is conducting researches toward solving the problem of producing aluminium from low-grade clays. The actual facts from a reliable source are to the effect that the Russians have few deposits of good bauxite and are, consequently, reported to have been spending time and money in the extraction of aluminium from clay. This is also true of Germany. It is technically feasible to extract aluminium from clay, and, in case of war, such a process might be of distinct value if the supplies of bauxite were cut off. None of the processes, however, so far described in the literature, or the processes which have been described as being the ones investigated by the Russians, would have any possibility of competing in cost with the current commercial processes for extracting alumina from bauxite.

In a paper read before the Institution of Chemical Engineers, Messrs. Bengough and Whitby described the successful application of their selenium process for the protection of magnesium alloys against marine corrosion. Specimens were immersed for 5–15 minutes in a solution containing 10 per cent. selenious acid and 0·5 per cent. sodium chloride, at ordinary temperature, and were then subjected to four months' exposure to sea-water spray, applied thrice daily, without suffering appreciable attack. The success of the process is attributed largely to the self-healing properties of the film, which are thought to depend upon the following reactions. The magnesium surface becomes coated with a thin layer of magnesium selenide, which is decomposed by water penetrating through pores in the selenium layer. The hydrogen selenide thus formed reacts with oxygen to give selenium, which seals the pores through which the water penetrated.

In a paper by M. J. Burgess and R. V. Wheeler, just issued by the Safety in Mines Research Board, an account is given of experiments carried out to ascertain the possibility of preventing the igniton of firedamp, caused by the striking of coal cutter picks against quartzitic sandstone by discharging an inert gas, carbon dioxide, into the cut made by the machine. In these experiments the carbon dioxide, in the solid form as used commercially, was carried on the coal-cutting machine in a standard liquifier, and the gas was directed through a copper pipe into the machine cut at the end of the jib. With the machine cutting against sandstone in an explosive atmosphere, it was found that while some ignitions of firedamp occurred when carbon dioxide was discharged into the machine cut at rates below 1½ cubic feet per minute, they were much less frequent than when no carbon dioxide was used, and when carbon dioxide was used at rates above 1½ cubic feet per minute no ignitions occurred. The paper may be obtained from H.M. Stationery Office, price 6d.

Miscellanea.

A rubber factory is to be put up at Travancore.

It is proposed to establish an aerodrome near Colombo, Ceylon.

A new passenger air service between Cairo, Luxor, and Assuan has been opened.

An aerodrome is to be constructed on the outskirts of Shanghai at a cost of £200,000.

During the past year the number of telephones in Great Britain has increased by 60,000.

Some extensive deposits of kaolin in the Soanlathi district of Finland are to be developed.

More gold was produced in the first nine months of this year in Australia than in the whole of 1932.

A large factory for the manufacture of synthetic rubber is being put up at Yaroslav, Russia.

A special pavilion is to be erected at the forthcoming Levant Fair by Imperial Chemical Industries.

Three ferry boats are to be built for the Trustees of the Clyde Navigation by Barclay, Curle and Co., Ltd., of Glasgow.

The Bombay Port Trust Railway is buying its supplies of 90-lb. rails and fish-plates from the Tata Iron and Steel Company.

The U.S. War Department announces plans for the purchase of 7776 motor vehicles for the mechanisation of the Army.

A new rolling mill for heavy work, with a daily capacity of 1500 tons, has been started at the Ilyich works at Mariupol, Russia.

The L.N.E.R. has placed orders with iron manufacturing firms at Nottingham, Blaydon-on-Tyne, Middlesbrough, Thornaby-on-Tees, and Alloa for 3480 tons of cast iron permanent way chairs.

The new carbonising plant of the Tottenham and District Gas Company, at South Gate, Willoughby-lane, Tottenham, which was formally inaugurated by the Duke of York on December 12th, has cost £125,000.

The Burntisland Shipbuilding Company, Fife, has received orders for a cargo steamer of 2850 tons from Messrs. Glen and Co., Glasgow, and a 1160 tons steamer for the London and Channel Islands Steamship Company.

A new turbo-generator of 12,000 kW, manufactured at the Stalin Works at Leningrad, is undergoing tests in the Moscow power-house. When this machine is in commission, a number of large Moscow buildings, including the Grand Opera, will be electrically heated.

The Government of Madras is understood to have issued orders sanctioning the construction of transmission lines for taking power from the Pykara Hydro-electric Works from Erode to Trichinopoly. The estimated cost of constructing these lines will exceed Rs. 20,00,000.

A message from Baghdad, published in *Indian Engineering*, states that the Anglo-Egyptian combine, Nuttall, Mowlem, Brand and Abboud (Near East), Ltd., has submitted the lowest revised tender (just under £1,000,000) for the Habbaniya Barrage on the Euphrates. The tenders are now being examined. The object of the scheme is to protect the lands of the Lower Euphrates from floods in the spring, and give the cultivators of Iraq more water for their crops in the late summer.

Plans are under consideration for the erection of a sulphuric acid plant in Palestine, the raw material to come from the sulphur deposits of Ghaza. It is understood, says the *Chemical Trade Journal*, that a decision to erect the plant is likely to be taken, since Palestine Potash, Ltd., are to embark upon the production of potassium sulphate from their crude potash salts. Superphosphate is also likely to be made in Palestine in the near future, utilising the domestic phosphate rock resources.

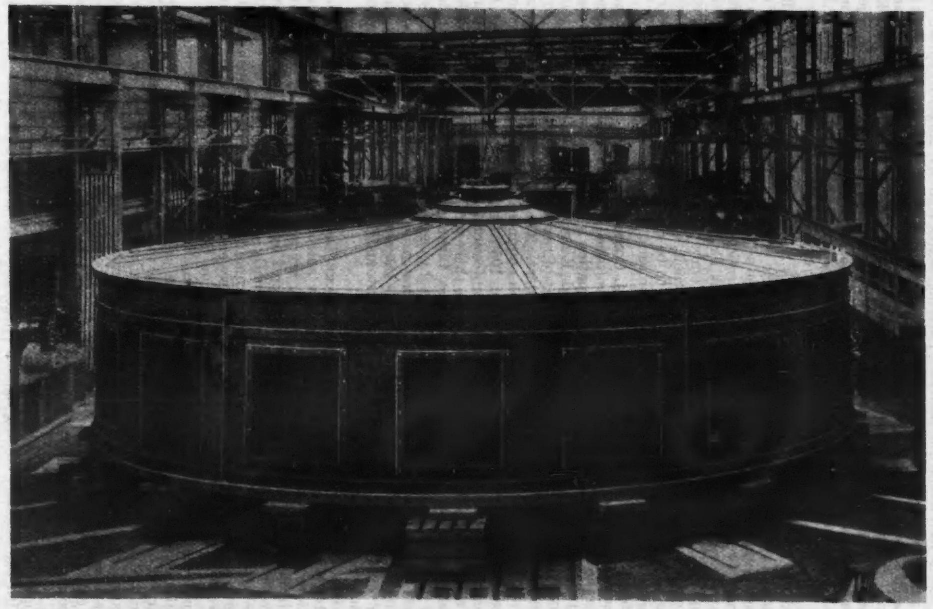
H.M. Consul at Kovno reports that he has been given an assurance by the Lithuanian Government that, in anticipation of the conclusion of a treaty between the United Kingdom and Lithuania, national treatment in respect of taxation will be accorded to British commercial travellers. The effect of this concession will be to exempt British commercial travellers from payment of the licence tax of 1050 lits., but it will not affect their liability to the professional tax of 50 lits. per month. In order to secure this exemption, commercial travellers must produce to the Lithuanian authorities a certificate of identity issued by an approved British Chamber of Commerce, and drawn up in accordance with the form prescribed by the "International Convention for the Simplification of Customs Formalities," which was signed at Geneva in 1923.

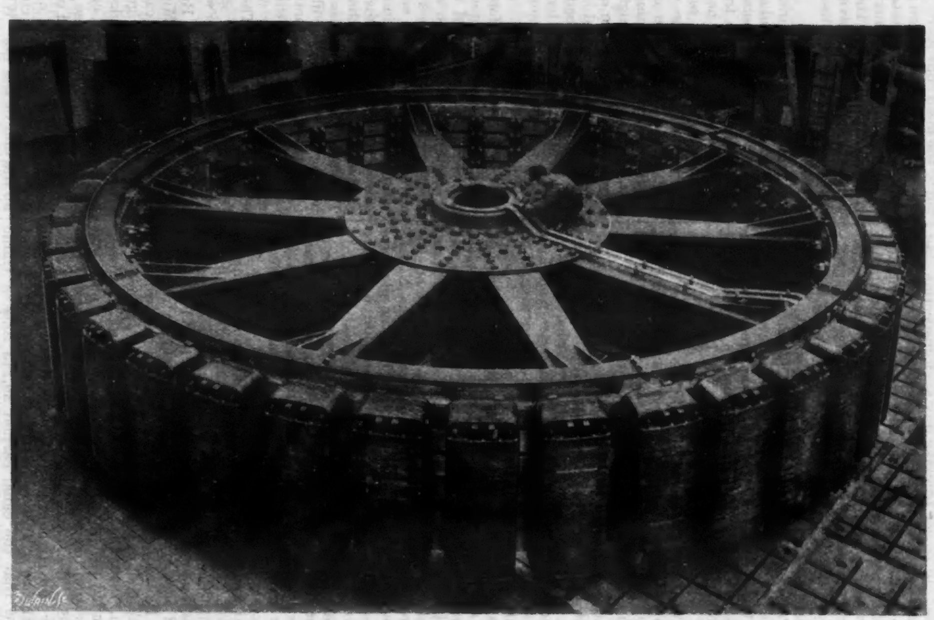
There died recently at his home in London an engineer whose active interest in his profession extended over nearly seventy-five years. Mr. H. C. Powell was born in 1842 and went to King's College, London, in 1858, while as recently as the end of 1932 he contributed some notes on aeronautics to a technical journal. He was associated with several important steps in engineering progress. Being on the staff of Mr. J. F. Spencer, when the North-Eastern Marine Engineering Company was formed, he became chief draughtsman in the works at Sunderland. Later he was engineer to the Antofagasta Nitrate Company and Railway in Chile. Then for ten years he managed the works of his cousin, M. Thomas Powell, at Rouen, where, besides other notable productions, the "Simplex" gas engine with electrical ignition was made in 1888. At that time he was also instrumental in putting a water-tube boiler in a tug on the Seine. This interest led to his acquaintance with M. Niclausse, with whom he negotiated the taking over of the manufacture in England of the Niclausse boiler by Messrs. Willans and Robinson at Queensferry. During the last twenty years Mr. Powell paid several visits to South America for engineering firms, and kept in touch with current developments in all branches of engineering, sending occasional communications to the Institute of Marine Engineers, of which, as well as of the Institution of Mechanical Engineers, he was a member for many years.

43,882-kVA 25-CYCLE HYDRO-ELECTRIC GENERATOR FOR THE BEAUHARNOIS POWER STATION

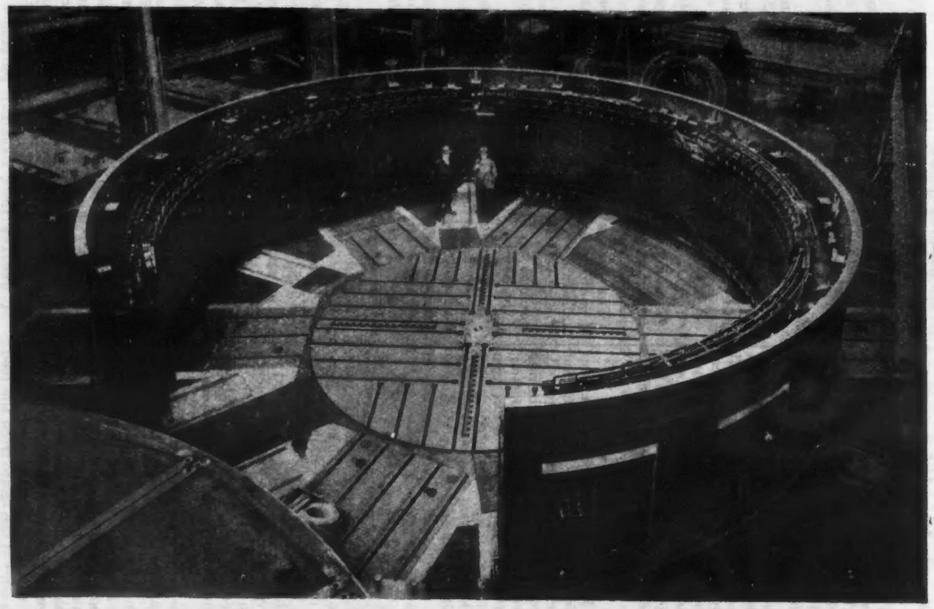
OERLIKON LTD., OERLIKON, SWITZERLAND, ENGINEERS

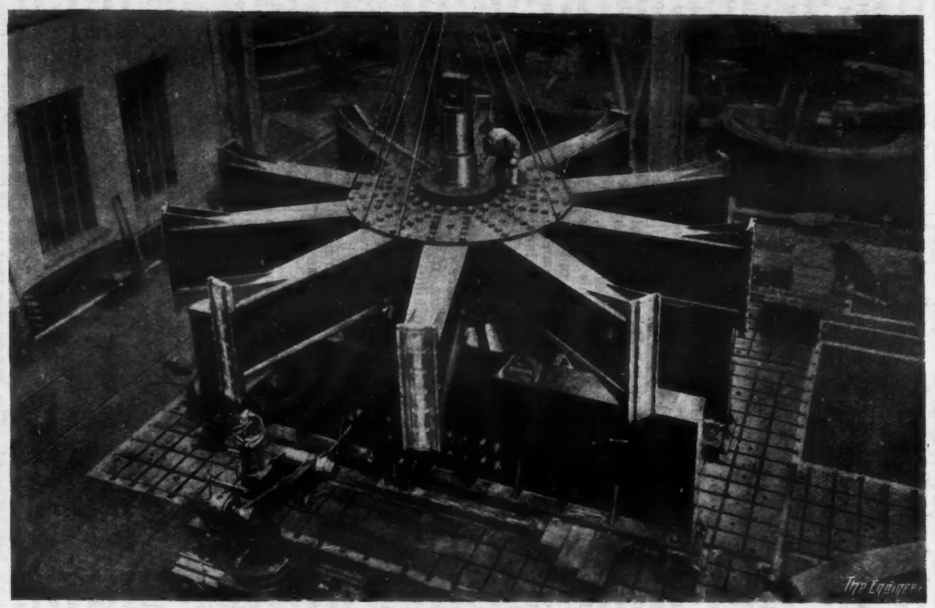
(For description see page 618.)





ABOVE:—COMPLETE STATOR IN ERECTING SHOP
BELOW:—COMPLETE 40 POLE ROTOR





ABOVE:—STATOR WITH ONE OF THE SECTIONS REMOVED
BELOW:—ROTOR SPIDER AND SUPPORTING GIRDER

The Engineer

DECEMBER 22, 1933.

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Development of the Parsons Steam Turbine.

The steam turbine is one of the landmarks in engineering industry. Coming at a time when the electrical age was beginning, it both made large scale electricity supply possible and was made by it. The first turbo-generator made under Parsons' patent of 1884 developed about 7·5 kW; single turbo-generators over 100,000 kW capacity are now running. The present estimated value of Parsons turbines alone is £152,000,000, the figures for marine and land turbines being £92,000,000 and £60,000,000 respectively. Nothing to equal that rapid extension of value and dimensions has ever happened before.

Before the death of Sir Charles Parsons we had taken preliminary steps for the publication of a series of articles on the development of the Parsons turbine to celebrate its jubilee. The preparation of that series has been delayed by one cause and another, and can now not benefit by his personal supervision, but if it lacks anything of the vivid touch which he might have given, it still remains a most fascinating history. We need scarcely say that the publication of the series, which will begin on January 5th, 1934, will occupy many weeks, but the history is one in which every engineer takes a deep interest and pride, and we have no doubt that our articles will be widely read and appreciated.

THE PRINCIPLE OF SIMILITUDE.

THE paper by Dr. Griffiths and Mr. Awbery, presented before the Institution of Mechanical Engineers on Friday of last week, was concerned with the transfer of heat between metal pipes and a stream of air. The temperature and other conditions of the experimental work on which the paper was based were such as to make the results chiefly applicable to the design of refrigerators and low-temperature air heaters. That being so, the particular appeal of the paper covers a somewhat narrow and specialised field. In one respect, however, it touches upon a subject of wide general interest. It provides an excellent example of the complexity of much modern research work, and of the advantages and limitations of the principle of similitude as a means of simplifying the presentation of the results. The object of the investigation was to measure the heat transfer and to determine in what manner it was affected by the diameter of the pipe, the temperature of its surface, the velocity of the air impinging upon it, and by other factors. At least ten variable factors are involved in the problem if a single pipe alone is considered, while several others are added if the pipe is one of a bank. To investigate the effect of each variable separately and to present the results in a readily comprehensible and applicable form would have been an arduous if not an impossible task. Resort was therefore made, as it is now commonly made in physical research under similar conditions, to the principle of similitude, that great generalisation of which Newton had some perception and to which the late Lord Rayleigh gave formalised expression. In its elements there is nothing either mysterious or abstruse about that principle. It centres on the requirement that any mathematical equation which we may devise to express an objective relationship between two or more quantities must, if it is to be rational, involve the fundamental units of length, mass, and time equally on both sides. In other words, the "dimensions" of both sides of the equation must be the same. If the dimensions on one side are, for example, $M L^2/T^2$—that is to say, those of energy—then those on the other side must also add up to $M L^2/T^2$. If they do not, the equation is wrong, and cannot express any relationship which could possibly exist in the physical world. The principle of similitude is particularly concerned with the case in which the dimensions of both sides add up to zero. If out of a multiplicity of factors affecting or likely to affect an observed result, we can choose or form two groups, each of which has zero dimensions, then, according to the principle of similitude, it is rational to search for a relationship between the two groups. Alternatively, if two groups have different dimensions, it is a waste of time to endeavour to find a relationship between them.

If the number of variables affecting the observed result is known to be restricted to not more than three the complete form of the relationship between the observed result and the variables can be discovered by a direct application of the method of dimensions. For example, the factors affecting, or possibly affecting, the periodic time of a simple pendulum oscillating through a small arc are the length of the cord, the mass of the bob, and the acceleration due to gravity. These three factors have to be combined in such a way as to make their dimensions add up to that of time. It is easy to prove that they can so add up only if the mass of the bob is without effect on the periodic time, and only if that time is determined by the square root of the length of the pendulum and by the reciprocal of the square root of the acceleration, g. The method of dimensions leads in this case directly to the precise relationship sought, namely, $T=k\sqrt{l/g}$. where k is a pure number. If, however, there are more than three variables affecting the observed result, the method of dimensions presents us with the insoluble problem of finding the values of four or more unknowns by means of three equations. In the case of Dr. Griffiths and Mr. Awbery's problem, the observed result was the quantity of heat energy transfer between the pipe and the air per unit length of the pipe per unit of time. The dimensions of this observed figure were, therefore, those of energy divided by length divided by time, or $M L/T^3$. The variable factors affecting, or believed to affect, the observed result, had, therefore, to be combined in such a way as to make their dimensions add up to unity with respect to mass and length and minus three with respect to time. A more general method of procedure—that actually adopted by Dr. Griffiths and Mr. Awbery—is to form from the variables a combination having the same dimensions as the observed result, and to divide the observed result by this combination so as to produce a group of zero dimensions. Then, if any relationship exists at all between the observed result and the variables supposed to affect it, it will lie between this dimensionless group and some other dimensionless grouping of the variables. This method of discovering a physical relationship is extraordinarily attractive, both from the practical point of view and because of its fundamental significance. It has, however, several limitations. It is not always possible to compile a list of the variable factors affecting the given result with complete assurance that it omits none which should be included, and includes none which should be omitted. For example, in the case of the simple pendulum already mentioned, a variable, the amplitude of swing, is omitted, although *a priori* we ought to expect it to affect the periodic time. The justification for that omission is derived not from the principle of similitude, but from precedent observation of the behaviour of simple pendulums and an analysis of that behaviour by the processes of general dynamics. Again, if the number of variables in the list is at all considerable, it is nearly always possible to form from them several groups having zero dimensions. Which of these groups should be selected for correlation with the dimensionless group containing the observed result? The principle of similitude gives us no guidance. It does not even tell us that there is bound to be a relationship between each and every pair of dimensionless groups that can be formed. All that it says is that if a real relationship exists it will be found between one such pair of groups. The selection has, therefore, to be made either by a process of trial or by guidance provided by previously acquired experimental or analytical knowledge. A third and very important element limiting the application of the principle of similitude arises if the problem under investigation involves thermal considerations. What dimensions are to be assigned to temperature, or to any factor, such as thermal conductivity, involving temperature in its composition? The usual procedure is to assign to temperature zero dimensions with respect to length, mass, and time, and to give it a special dimension, θ, of its own. On this basis the dimensions of temperature are $M^0 L^0 T^0 \theta^1$ and of thermal conductivity, $M^1 L^1 T^{-3} \theta^{-1}$, and to the dimensions of all quantities which do not involve temperature we may, if we please, add the symbol θ^0. This practice ensures that a proper account is taken of temperature and prevents the possibility of a relationship being sought between two groups of factors which are of the same dimensions with respect to length, mass, and time, but differ with respect to their temperature dimension. On the other hand, the practice has a restrictive effect, for if dimensions in length, mass, and time can be assigned to temperature, additional non-dimensional groups can be formed from the variables entering into a thermal problem. These groups are ignored if temperature is given a special dimension θ, yet it may quite well happen that among them is the group that we are seeking. The selection of some other group in these circumstances can at best yield only an approximate relationship, and may result in the experimental investigation being directed along lines that will miss the point.

The suggestion that temperature has dimensions with respect to length, mass, and time, and that there is no necessity to assign to it a special dimension of its own, is not novel. It arises naturally from the kinetic theory of gases. According to that theory absolute temperature is proportional to, and is a measure of, the kinetic energy possessed by unit mass of the gas. Since energy has the dimensions $M L^2/T^2$, energy per unit of mass has the dimensions L^2/T^2. Hence, it would seem that the dimensions of temperature are two with respect to length and minus two with respect to time, or, in other words, that they are identical with the dimensions of a velocity squared. A consistent list of the dimensions of all other thermal quantities can be drawn up if these dimensions are assigned to temperature, and each entry in that list, being expressed in terms solely of length, mass, and time, can be homogeneously combined with any non-thermal variable. For example, the dimensions of thermal conductivity now become $M^1 L^{-1} T^{-1}$. The dimensions of heat, it may be remarked, remain unaltered at those of energy, those of specific heat become zero, while entropy per unit mass and R the gas constant in the equation $p v=R T$ become pure numbers. From the practical or experimental point of view, the assignment of length and time dimensions to temperature has a bearing which may be of much importance in the interpretation and application of the results. If the variables include temperature and the velocity of a stream of fluid, as in Dr. Griffiths and Mr. Awbery's work, then $\sqrt{T}/V$ is non-dimensional, and therefore in order that the principles of dynamical similarity may be fulfilled, any change in the velocity V of the stream ought to be accompanied by a proportional change in the square root of the temperature. It is possible that the omission of this observance may have accounted for certain discrepancies in Dr. Griffiths and Mr. Awbery's results, and for their difficulty in fitting them to a rational law based on the principle of similitude.

The Cunard Liner.

No news in recent years has given quite the same satisfaction, both in engineering and industrial circles, as the statement made by Mr. Neville Chamberlain, the Chancellor of the Exchequer, in the House of Commons last week on the subject of financial facilities for the building of the Cunard liner "No. 534," now on the stocks at John Brown's Clydebank yard. Mr. Chamberlain said that he was glad to inform the House that the difficult and complicated negotiations, which had been conducted with great goodwill on all sides, had reached a stage at which the Government felt justified in assuming that an effective merger of the North Atlantic fleets of the Cunard and White Star lines would become an accomplished fact at an early date. In that event it was the intention of the Government shortly to lay before the House proposals for furnishing the necessary financial facilities for the completion of "No. 534." In reply to a question as to whether the proposals would contain any reference to the possible construction of a second ship, Mr. Chamberlain said that it would be better to await the Government's proposals. According to official statements which have since been made by the Cunard and the White Star companies, the two companies are in touch with one another, both directly and through their solicitors, and are busily engaged with the drafting of the many documents which the proposal entails. Both national and technical reasons for the construction of the Cunard liners were given in our leading article of October 7th, 1932, entitled "Build the Cunarders." We have little to add to that statement.

There are many preliminary matters to be settled before work can actually begin at Clydebank, but it is confidently expected that operations will be restarted early in the New Year, and that the resumption of work upon the ship will be progressive. It is satisfactory to learn that the hull is in the best of conditions, both as regards its alignment and with regard to its protection from rusting. As is well known, the building berth is that which the "Aquitania" occupied at Clydebank, strengthened and extended where necessary. Its structure has proved so sound that no perceptible change in position of the hull has taken place. The technical staff of John Brown and Co., Ltd., under the leadership of Sir Thomas Bell, is to be congratulated on the success which has attended its constant care of the hull and its supports, and the protection of the framing and plating from corrosion. When work on the liner was stopped close upon two years ago, much had already been done by the Clyde Navigation Trustees towards preparing the bed of the river Clyde for the launch. That work is now so well advanced that it will be easily completed before the ship is ready for launching, sometime next year.

Heat Transfer Between Pipes and Air.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Friday evening of last week Dr. Ezer Griffiths and Mr. J. H. Awbery, both of the National Physical Laboratory, presented before the Institution of Mechanical Engineers a paper entitled "Heat Transfer between Metal Pipes and a Stream of Air." This paper, an abridgment of which will be found elsewhere in this issue, was originally prepared as a report to the Engineering Committee of the Food Investigation Board, of which Committee Sir J. Alfred Ewing is Chairman.

Following Dr. Griffiths' presentation of the paper in summary, Sir Alfred Ewing was called upon by the President, Mr. A. E. L. Chorlton, to open the discussion. Sir Alfred said that the Food Investigation Board was one of the most active sections of the Department of Scientific and Industrial Research, and, like other bodies set up by that Department, consisted of a judicious combination of practical men professors, and scientists. Nearly all the research work for the Board had been conducted at the National Physical Laboratory, and very largely under the control of Dr. Griffiths, to whose skill and care as an investigator the Board was deeply indebted. The main purpose of the investigations described in the paper was to obtain data which would assist refrigeration engineers to design banks of pipes for cooling air, but it was later realised that the results obtained had a wider general interest to mechanical engineers, and hence the report was offered as a paper to the Institution. The striking new fact brought out by the research was the immense effect on the heat transfer produced by turbulence in the air. He pictured the air striking the first row of a bank of transverse tubes and flowing round the tubes of that row in a streamline manner until some way round the rear half of the circumference where a certain amount of turbulence would develop. The second row of tubes therefore received the air in a turbulent condition, and passed it on in a still more turbulent condition to the third row, a limiting state of turbulence being subsequently reached. That condition, he said, served to explain why it had been found that the heat transfer increased from row to row towards a limiting value. There could be no doubt whatever that air in turbulent flow was in a better condition to pick up heat or to part with it than air in streamline flow. The difference was as great as that between the solution of sugar in a cup of tea when the tea was stirred and when it was not stirred.

Dr. C. H. Lander said that the increased heat transference at the second and third rows of a bank of pipes was a very interesting and unexpected fact. At the Imperial College of Science Dr. Fishenden and Mr. Saunders were at present conducting an investigation on the transfer of heat between a heated surface and a fluid in motion past it. The experimental method employed was based on the fact that in the region adjacent to the surface there was a substantially stationary layer of the fluid across which the temperature dropped at a uniform rate. If a beam of light were directed to pass axially through the stationary layer it would be deflected—see Fig. 1—and it could be shown theoretically that the deflection x was proportional to the heat transference at the section of the heated surface under examination. When a tube exposed transversely to a current of fluid was examined in that manner, the image of the deflected rays passing through the stationary layer produced a closed figure, the radial distance between which and the boundary image of the tube was proportional at any point to the heat transference occurring at that point. In nearly every instance the figure cast by the deflected rays was not an exact circle, but slightly heart-shaped, indicating that the heat transference was not uniform all round the tube wall, but was affected by some difference in or adjacent to the stationary layer. When a group of three tubes was exposed to a transverse stream of air the images were distorted in the manner shown on the screen—see Fig. 2. It would be noted that the heat transference over the lower portion of the upper tube had been greatly increased by the presence of the two lower tubes. By integrating round the circumference of the tube, the total amount of heat transferred could be calculated. The slide did not altogether support the authors' finding as to the increased efficiency of the second row of tubes in a bank. It must, however, be remembered that it showed only one tube in the second row, and that, judging from the effect on one another of the two tubes in the first row, the addition of a second and third tube in the second row would considerably increase the heat transfer of the central tube.

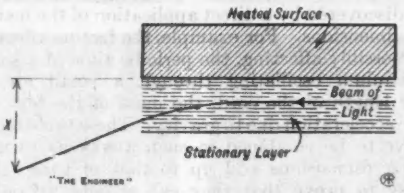


FIG. 1

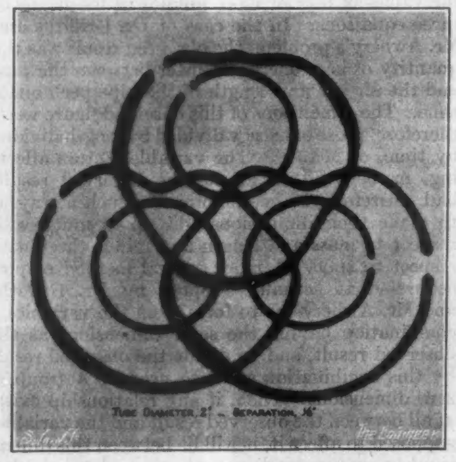


FIG. 2

Dr. Margaret Fishenden, dealing with the effect produced by artificially created turbulence, commented upon the fact that such turbulence raised the heat transfer of the first layer in a bank by about 100 per cent., and that of the second by about 50 per cent., thereby bringing the heat transfers of the two layers into practical equality. The level to which the heat transfers of the first and second rows was thus raised was found to be greater than that of the heat transfer from the third, fourth, and fifth layers without artificial turbulence. Dr. Fishenden thought this fact was curious, for it seemed to suggest that without artificial turbulence, the induced turbulence at the third and later layers did not really represent the limiting value. Was it possible, she asked, that the effect of artificial turbulence was confined to the first and second layers, and that thereafter the heat transfer fell towards the limiting value corresponding to the turbulence induced at the later layers when no artificial means of creating or increasing it was employed ?

Mr. F. C. Johansen criticised the authors for assigning dimensions to specific heat. Specific heat, he said, represented the ratio of two quantities of heat just as specific gravity represented the ratio of two weights, and was, therefore, a pure number. The quantity which the authors used as specific heat should preferably be called volumetric heat capacity. Dealing with the authors' method of presenting their results, he said that their selection of the dimensionless quantity $H/k\,\theta$ was not wholly satisfactory as it did not include a velocity term. It was, in his opinion, essential to include velocity in the variable if the coefficient was to be a true constant. Various dimensionless variables could easily be devised which would include velocity. For example, both $h/c\,V\,\theta$ and $h\,\nu/k\,V\,\theta$ were dimensionless. The fact that the heat transfer depended upon the Reynolds number emphasised the close connection which existed between heat transference and aerodynamical resistance. In the case of a long cylinder exposed to a transverse flow of air, the aerodynamical resistance was found to be fairly constant for Reynolds numbers lying between 4 and 5, and over that range he would expect that there would be a corresponding fairly uniform heat transference law. Above 5 and below 4, however, the aerodynamic resistance changed in such a way as to suggest that there would be great changes in the heat transference law. He, therefore, suggested that the empirical law deduced by the authors from their single tube experiments would be found to be applicable only to conditions duplicating the Reynolds numbers of the authors' experiments. In plotting their curves the authors had in all cases continued the curve without inflexion until it met the vertical axis at a point representing the heat transfer for zero velocity of the air. Some experiments which he had conducted on a hot wire anemometer for use in calibrating a pitot tube to work at very low velocities revealed the fact that at very low velocities the heat transfer from the wire was actually less than when the velocity was zero—that was to say, the static convection was actually greater than that produced by a very low velocity. The heat transfer curve had, therefore, a minimum at some velocity greater than zero, and from that minimum rose up to intersect the vertical axis at the point corresponding to the heat transfer at zero velocity. Some similar inflexion in the curve would probably be found to apply in the authors' case. Dealing with the authors' experiments on the heat transfer to cold pipes, he commented upon their observation that the heat transfer was greater when the pipes dripped water than when they were dry. He could not quite understand the action which was taking place when water was dripping from the pipes, but if the observation were correct, it seemed reasonable to suggest that practical advantage would accrue in a cold store if the air at the inlet to the cooler were kept very moist.

Professor A. L. Mellanby thought that the authors might do something to facilitate the task of any one who had to design from the data given in the paper a practical air heater or air cooler. He commented also upon the comparisons which the authors made between their results and those of others. In view of the considerable amount of agreement which they apparently had found, he desired to ask them whether they thought that the work described in the paper had really been worth while, or whether it amounted largely to the repetition of the work of other investigators.

Dr. J. N. Long asked whether the snow which formed on the cold pipes maintained a circular outline. Aerodynamically there was a region of positive pressure extending round a section of about 78 deg. of angle at the front of a circular pipe exposed transversely to a wind stream, the remainder of the surface being under a negative pressure. He would have expected that in the authors' cold pipe experiments the snow which formed would reflect that fact and would pile up on the positive pressure side, giving the coated pipe other than a circular section. He agreed with Dr. Mellanby concerning the omission from the paper of certain data that would be required by practical designers. For example, no information was given concerning the number of tubes in a bank which would be required to give a stated amount of cooling. He also commented upon the absence of information regarding the effect of pitching the first two rows at wider intervals than the others, a practice which, he said, he thought would in time become common.

Mr. W. F. Cope commented upon the authors' statement that they had been unable to find any reference to previous work on the transfer of heat between a pipe and air flowing axially along its outside surface. A great deal of work had been done on the transfer of heat between a pipe and a fluid flowing along its interior. Comparing the authors' results with experiments on the heat transmission in locomotive boiler tubes, he found that the heat transfers obtained by the authors were about 20 per cent. greater. In the case of heat transfer in condenser tubes, however, the figures were in marked agreement with the authors' results. That fact was surprising in view of the great difference in the conditions.

Dr. A. P. Thurston said that it was well known that the cooling effect of a stream of air impinging on a hot wire was proportional to the velocity of the air and its density. It was evident from the authors' results that the same law applied in the case of a pipe laid across a current of air. In aerodynamics it had been found that if two similar cylinders were exposed to an air current, and if the gap between them were reduced progressively, a point was reached at which the combined air resistance of the two pipes suddenly became less than that of one pipe alone. That fact led him to ask whether the authors had made any experiments in which the spacing between the tubes in the rows had been varied. He also suggested that it might be worth while investigating the effect of rider planes attached to the outside of the pipes. Such rider planes had been shown to have a marked effect on the air resistance of cylinders, and it was possible that they might similarly affect heat transfer.

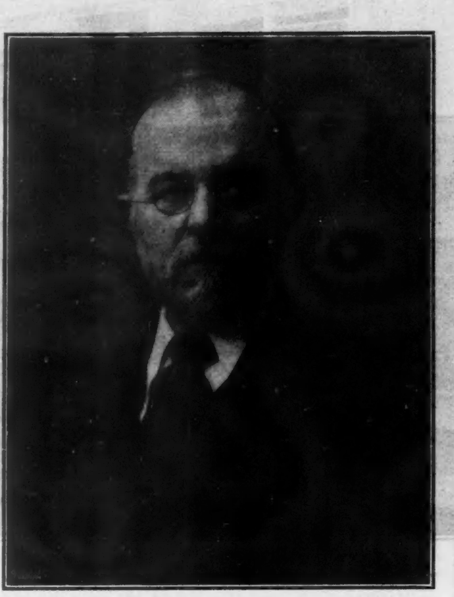
Mr. J. H. Awbery, replying to the discussion, expressed the hope that many more results might be forthcoming from the method of studying local conditions of heat flow described by Dr. Lander. The limiting value of the turbulent effect had puzzled them very much. The fact that the heat transfer for the third, fourth, and fifth layers was substantially the same, seemed to suggest that at these tubes the turbulence reached the limit of its effect. Yet it was undoubtedly true that artificial turbulence could increase the heat transfer for the first and second rows above the limiting value for the third and later rows when artificial turbulence was not used. It would seem that the limit of turbulence which the bank of tubes could produce was less than that which could be produced artificially. It might possibly be as Dr. Fishenden had suggested, that with artificial turbulence the heat transfer would in the later pipes revert to the limiting value which it would have had if artificial turbulence had not been used. He was far from being sure whether specific heat was a dimensional or a non-dimensional quantity, just as he was not sure whether specific gravity was a pure number or so many grammes per cubic centimetre. It was quite possible that some form of selected variable other than that which they had chosen might be more advantageous to users of the data collected during the research. There was no reason why the change should not be made. Replying to Mr. Johansen, he said that his suggestion seemed to be that if water dripping from the pipes gave a better heat transfer, a still better result would be achieved by running a cooling bank under such conditions that that water turned to ice, thereby giving the bank the benefit of both the latent heats. In such a condition the bank would not be operating under steady conditions, for if ice were forming on the pipes their diameter would be growing. Dealing with Dr. Mellanby's remarks, he said that the comparison of their results with those of others showed not unnecessary duplication, but differences amounting in some cases to as much as 50 per cent. The snow on the cold pipes did not deposit uniformly all round. The shape was peculiar, but it was too difficult to measure or draw accurately. They had, therefore, assumed that the snow-covered pipe was externally circular and of a diameter corresponding to its measured periphery. Actually, the shape was much as it would be if it corresponded to the distribution of pressure and suction round the pipe. They had not as yet investigated the effect of varying the pitch uniformly throughout the bank. Still less had they studied the effect of unequal pitching of the pipes. He thought Dr. Thurston's suggested use of rider planes on the pipes was an interesting one, and would like to investigate their effect.

Obituary.

DR. JAMES TAYLOR MILTON.

MARINE engineers and naval architects throughout the world will learn with regret of the death of Dr. J. T. Milton, a late Chief Engineer Surveyor of Lloyd's Register of Shipping, which took place at his home at Emsworth, Hampshire, on Wednesday, December 13th.

Dr. Milton, who was eighty-three years of age, was born at Portsmouth, served his apprenticeship in Portsmouth Dockyard, and studied at Greenwich College, where he was one of the outstanding students of his year. In May, 1875, he joined Lloyd's Register of Shipping as an engineer surveyor, and at once took a share of the outdoor surveying work of the Society in the London district, and of the work of the Engineering Department. When he joined the Society it had no rules for engines and boilers. He it was who framed the first rules, and during his long period of service made successive revisions of them, formulating new rules as fresh problems arose. His tenure of office covered an interesting period of rapid advance and change in marine engineering practice. Some outstanding developments which he saw and advanced were the use of Siemens-Martin basic steel for boilers; the introduction of corrugated furnaces; and the coming, first, of the triple-expansion, and then of the quadruple-expansion engine with increased boiler pressures. Another important advance was the introduction of the Parsons steam turbine, first with the direct drive, and then with reduction gearing. Shortly afterwards there followed the Diesel and other oil marine engines, and the use of oil fuel for boiler firing. In all these developments Dr. Milton kept fully abreast of the advances made and formulated appropriate Lloyd's rules. From May, 1875, to June, 1921, when he retired from the office of Chief Engineer Surveyor, which he held with honour from 1890, Dr. Milton only spent four years away from Lloyd's Register of Shipping. In 1886 he left the Society to become manager of the marine engine works of R. and W. Hawthorn, Leslie and Co., Ltd., but he returned in 1890 to take up the position of Chief Engineer Surveyor.



DR. J. T. MILTON

He was a member of the Institution of Civil Engineers, and a recipient of the Telford Medal. In June, 1921, the University of Durham conferred upon him the honorary degree of Doctor of Science. Among other offices he was a Vice-president of the Institution of Naval Architects, a Past-president of the Institute of Marine Engineers, and a member of the North-East Coast Institution of Engineers and Shipbuilders, the Institute of Metals, the Liverpool Engineering Society, and the Ice and Cold Storage Association, of which Society he was at one time a President. He served on several Government Committees, dealing with petroleum and oil fuel problems, and was a member of the Committee appointed by the Cunard Steamship Company to advise on the most desirable type of machinery for the "Lusitania" and "Mauretania."

Dr. Milton presented several important papers to the various technical institutions, among which may perhaps be mentioned that of April, 1911, on "Diesel Engines for Sea-going Vessels," read before the Institution of Naval Architects, in which he gave a valuable account of Continental progress with the Diesel engine. He was a personal friend of the late Dr. Rudolf Diesel, and was largely instrumental in putting forward his claims in this country. In April, 1914, Dr. Milton further reviewed the oil engine position in a paper read before the Institution of Naval Architects on the "Present Position of Diesel Engines for Marine Purposes." Other papers included his Lloyd's report of May, 1912, on the "Spontaneous Combustion of Coal," and several papers before the Institute of Marine Engineers dealing with such important subjects as cast iron, brass, and other copper alloys used in marine engineering.

To few marine engineers has there been granted a more useful, varied, and honoured life. The end came suddenly and peacefully following the shock of the death of his illustrious brother, Engineer Rear-Admiral Milton, who died a few days before his brother James, also at Emsworth.

The late Admiral Milton was aboard the "Calliope" at the time of the Samoan hurricane, and carried out many Admiralty trials, including some of the first in which the Admiralty put the engines from full ahead to full astern without shutting off steam.

TOM CRAVEN.

WE have to record with regret the death of Mr. Tom Craven, who for half a century was an active partner in the firm of Gresham and Craven, Ltd., of Manchester, which was founded by his father. He was also for many years a director of Beyer, Peacock and Co., Ltd. He was eighty-three years of age, and although he had lived in London since his retirement, he used for a time to make regular visits to the works.

SIXTY YEARS AGO.

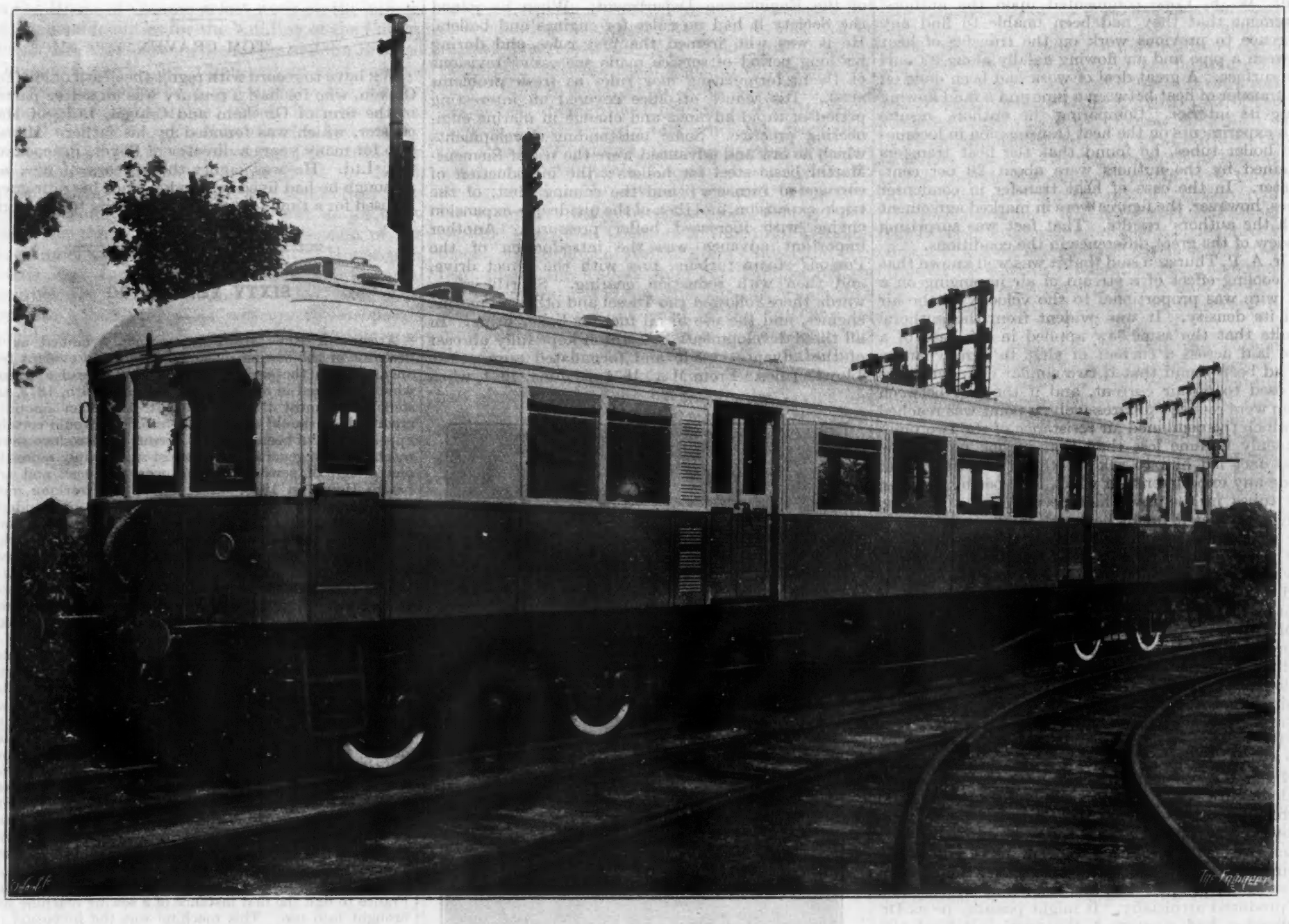
ALTHOUGH Elias Howe is commonly named as the inventor of the sewing machine, it is quite evident from an article on the early history of that useful appliance, which appeared in our issue of December 26th, 1873, that some doubt must always exist as to the exact amount of credit which should be given to him. He would certainly appear to have been the first person to introduce sewing machines into general use, but just as certainly more than one design of sewing machine was produced and tried before Howe, in 1845, finished the first working model embodying his ideas. To Thomas Saint of London a patent was granted in 1790 for a method of making boots. In Saint's specification a design of sewing machine working a chain stitch with a single thread, an awl and a needle, was briefly described. Saint's patent specification was for a long time hidden in the archives of the British Patent Office, and was only brought to light by an American sewing machine manufacturer in 1872, when seeking evidence to support the great attack on the validity of the Howe patents. Even, however, if we omit Saint's claim to priority, we have to take account of more than one other invention which preceded Howe's. Thus in 1804 Stone and Henderson—presumably two Englishmen—were granted a French patent for a machine intended to imitate hand sewing. This machine worked with an ordinary needle, which was passed backwards and forwards through the fabric by a pair of jaws which turned its point towards the fabric at each passage. In England, about the same time, several embroidering machines were invented, notably Duncan's of 1804, which with very little alteration could have been converted into chain-stitch sewing machines. In 1818 Adams and Dodge, of Monkton, Vermont, produced a sewing machine of some sort, but little is known of it. It would seem that we have to go to France to find the first instance of a sewing machine being brought into use. This machine was the invention of a poor tailor, Barthlemy Thimonnier, of St. Etienne. It was produced in 1839 and was constructed of wood. Beaunier, an engineer, saw the machine and persuaded Thimonnier to take it to Paris. A company, Ferraud, Thimonnier, Germain, Petit et Cie., was formed and established a factory in the Rue de Sèvres in 1841. Eighty wooden machines were installed and were set to work on a contract for Army clothing. Within less than a year, however, a mob of workpeople attacked the factory, destroyed the machines, and drove the inventor from Paris. In 1847 Thimonnier's machine was taken up by Magnin, of Villefranche, who patented it in his own name in England, and eventually sold his rights in it to a Manchester company. In 1848 another workshop equipped with the machines was set up in Paris, but it, too, was attacked by a mob. Concerning the respective claims of Hunt, Howe and Singer in the United States, the position is and must always remain obscure. Chronologically, Walter Hunt in 1834 came first, but it is not certain whether his was a practical machine. Howe is stated to have conceived his idea in 1839. His machine and Hunt's possessed considerable similarity, but there is every reason to believe that the duplication was unconscious. Singer came on the scene when Howe's machine was just beginning to attract attention. Singer caused Hunt to reconstruct one of his machines and sought to oppose Howe's claims. There was much litigation, which ended in Singer agreeing to pay Howe a royalty. In this country Howe was forestalled by Fisher and Gibbons, of Nottingham, who, in December, 1844, made and patented a machine for working ornamental designs on lace. This machine embodied the elements of a Howe sewing machine to such an extent that it was held to invalidate Howe's patent, parts of which were accordingly disclaimed.

IN essence, the instrument installed in the National Physical Laboratory for standardising radio wave lengths is a tuning fork of the same general form as that used by musicians as a standard of pitch, and the researches which have enabled the extraordinary degree of accuracy of modern radio communication to be reached consist of experiments on methods of mounting the fork and of securing exact balance of its two prongs; an investigation of the effects of slight changes of temperature and atmospheric pressure, and the means of avoiding them; a study of the electrical circuit used to maintain the fork in continuous vibration, and the magnetic coupling of this circuit to the form; and, finally, the means of determining to the highest accuracy the frequency of the fork. The complete standard equipment includes a chronograph specially designed by Dr. Dye for this purpose. Mere inspection of the chart of this instrument enables the frequency of the fork to be read with an accuracy of one part in ten million in terms of time, as measured by the standard clock of the Laboratory. This would represent a deviation of not more than about 8 seconds a year if the fork was running continuously for that period.

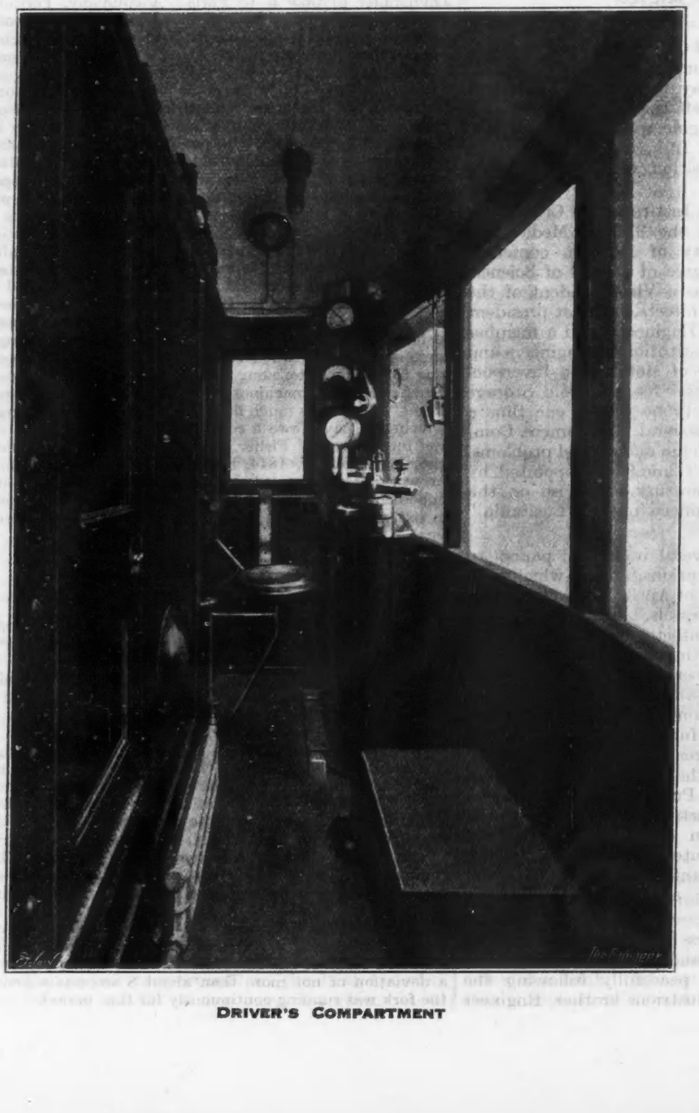
OIL-ELECTRIC RAIL COACH

THE ENGLISH ELECTRIC COMPANY, LTD., ENGINEERS

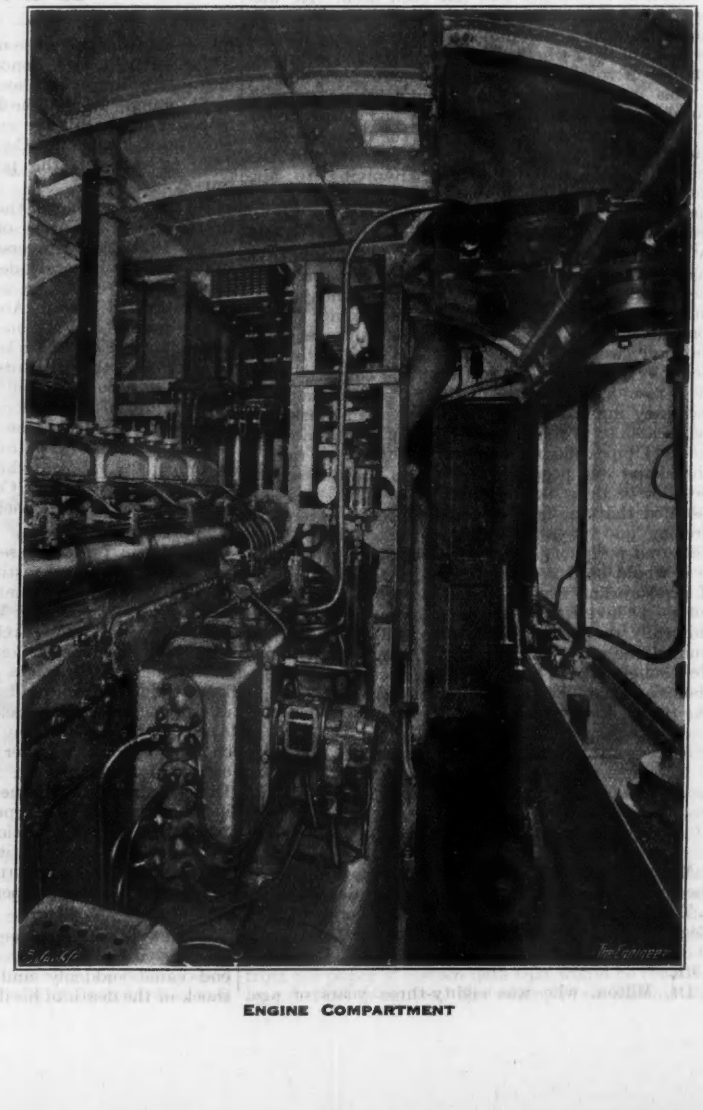
(For description see opposite page.)



200 H.P. OIL-ELECTRIC RAIL COACH



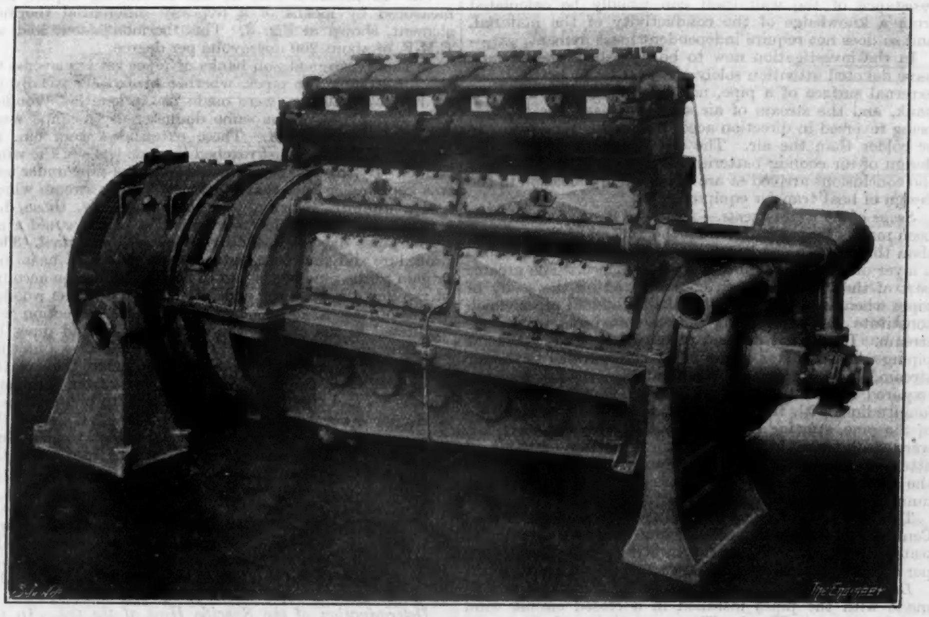
DRIVER'S COMPARTMENT



ENGINE COMPARTMENT

200 H.P. Oil-Electric Rail Coach.

ALTHOUGH the English Electric Company did pioneer work in the development of rail vehicles equipped with internal combustion engines, it has always maintained that the best system of propelling trains is governed by conditions, and that when considering the question of using motive power other than steam, each case should be examined individually in the light of all requirements. At the company's Dick, Kerr works, Preston, much experience in the construction of internal combustion engine rail vehicles has been gained. During the war many 40 horse-power petrol-electric locomotives were built. Subsequently, 100 horse-power petrol-electric rail car equipments were made for the Uruguay State Railways, a 50-ton, 100 horse-power petrol-electric breakdown locomotive for the Montreal Harbour Commissioners, electrical equipments for 200 horse-power oil-electric rail cars on the San Sebastian–Pamplona Railway, Spain, and complete 200 horse-power oil-electric coaches for the Venezuela Central Railway. In conjunction with Armstrong, Whitworth and Co., Ltd., the company also provided the electric control and motor equipments for the three oil-electric mobile power-house trains described in our issue of Nov. 25th, 1932, and for the oil-electric locomotives put into service this year on the Buenos Aires Great Southern Railway. Examples of vehicles fitted with mechanical transmission by the Company's association with the Drewry Car Company are the 100 horse-power motor coaches and the 300 horse-power locomotives which were built at the Dick, Kerr works, Preston, and supplied by the Drewry Car Company to the Bermuda Railway.



Power Unit of Oil-Electric Rail Coach

A 200 horse-power English Electric oil-electric rail car has recently been put into service on the Watford–St. Albans branch of the L.M.S. Railway. The coach body and bogies were built at the maker's Preston works, the engine at the Willans' works, Rugby, and the electrical equipment at the Phœnix Works, Bradford. Designed for branch line working, the coach is capable of hauling a standard 27-ton trailer coach and of performing incidental shunting work, such as necessary on branch lines in this country. Illustrations of the complete car, and the engine and driving compartments are given on the opposite page. The leading particulars of the vehicle are :—

Length over buffers	62ft. 10½in.
Length over body	59ft. 6in.
Width overall	8ft. 11⅜in.
Height overall	12ft. 11⅛in.
Seating capacity as at present arranged ..	53
Maximum seating capacity	61
Weight in working order, but without passengers or baggage	37½ tons
Maximum speed	60 m.p.h.

Composed of rolled steel sections riveted together, the underframe is well braced and gussetted. A swing bolster at the engine end carried by four swing links with nests of four spiral springs and rubber shock absorbers, serves to eliminate vibration. Finished in hand-polished mahogany and bubinga, with mahogany mouldings, the interior of the passengers' compartment presents a fine appearance. All-metal fittings are chromium plated. The seats are upholstered in figured moquette, and have removable cushions. Passengers enter the coach through a centre entrance controlled by sliding doors. A total of fifty-three seated passengers can at present be carried, but by a variation of the existing seating plan the number can be increased to sixty-one. Above the waist line at the trailing end of the coach the partition between the driver's cab and the passengers' compartment is composed of glass, so that during the day a view is obtained through the coach end, which is covered by blinds at night. A luggage compartment divides the passenger compartment from the engine-room, the bulkhead on the passenger side being lined with sound-deadening material. The engine-room is composed of steel throughout, and a removable roof allows the power unit to be lifted out for a complete overhaul. Where there is insufficient headroom to allow of this, however, the end of the coach body can be removed to permit the power unit to be drawn through the end of the coach on rollers.

Driving controls are provided at each end of the vehicle, and the equipment is designed to permit of multiple unit working. The plate frame type bogie under the engine compartment carries two axle-hung driving motors. The trailing bogie is built up of steel sections, and like that under the engine compartment it has S.K.F. roller bearing axle-boxes. A vacuum brake acts on all the wheels, while a screw-down hand brake operating through the power brake rigging, acts on the wheels of the driving bogie.

The power unit shown below consists of a vertical four-stroke English Electric mechanical injection cold starting six-cylinder oil engine, coupled to a 135-kW generator built and rated in accordance with traction practice. The engine, with 6in. by 8in. cylinders, develops 200 horse-power at 1500 r.p.m., and will give a maximum output of 220 horse power for 15 min. Running speeds of 1200 and 900 r.p.m. are available when the full output is not required. From the master controller the engine speed is controlled by a patented system, involving the use of solenoid operated valves to admit the lubricating oil under pressure to control cylinders, which alter the governor control spring settings and the timing, and arranged so that in the event of the oil pressure failing the engine is shut down. A centrifugal pump driven from the crank shaft circulates water through the engine jackets and radiator, which incorporates an oil cooler. Trunnions are arranged to give a three-point suspension for the engine and generator, and stresses in the crank case or shaft due to whipping or strain in the coach underframe are avoided. The arrangement not only makes a heavy bed plate unnecessary, but also avoids the need for special rigidity in the coach underframe. With a view to reducing the noise and vibration transmitted along the coach to a minimum, the power unit bearers and their fixing bolts are insulated with rubber from the underframe. A separately mounted chain-driven exciter has been provided to reduce the overall length of the set. The control gear, comprising the reverser, motor contactors, battery cut-out, &c., is assembled in a frame mounted over the main generator, and the making of connections between this apparatus and the external cables is facilitated by the provision of terminal bars, so that the control gear frame can be quickly disconnected and dismantled for overhaul or repairs. An electrically operated exhauster is mounted in the engine compartment.

Much consideration was given to the design of a heating system suitable for warming the rail coach and any trailer it may be called upon to haul. While electric heating from the main or auxiliary generator only calls for simple equipment, heat is only obtainable while the generator is running. This entails running the engine light in order to pre-heat the coach before putting it into service, and as the engine is shut down during periods of coasting, and while standing in stations, it is difficult to maintain an adequate temperature in the passenger compartments. Another disadvantage of the electric system is, of course, that it is impossible to supply heat to ordinary trailer coaches, equipped for steam heating. For the same reasons heating from the engine exhaust or circulating water is also unsatisfactory, and a low-pressure steam heating system, using a boiler fired with the same oil as employed for the engine, has therefore been adopted. Steam circulates through radiators fitted under the seats of the passenger compartment, and the condensate returns to the boiler through a feed tank. Apart from the occasional replacement of water rendered necessary to compensate for losses, the system is fully automatic. If for any reason the boiler flame is extinguished or the boiler water level falls to the limiting point, the oil supply is interrupted. The feed pump is automatically controlled by the water level. At each end of the coach there are standard hose couplings, so that steam can be supplied to any standard passenger coach used as a trailer.

Less than one hour's tuition is said to have been necessary to make men who are quite unfamiliar with this type of vehicle competent drivers. While the car is running the engine-room calls for no attention, and the control is very simple. The vehicle is designed for one-man operation, the master controller having a dead man's button. After a push-button switch, which sets up the circuit for motoring the generator from the battery, has been operated, movement of the master controller handle raises the engine speed from the idling value up to 1500 r.p.m. in three steps, and then weakens the traction motor field. If the controller handle is moved back towards the idling position the weak motor field position is retained until the idling position is reached, so that economy of engine power is combined with maximum electrical output.

By bringing the master controller handle to the engine "Shut down" position, advantage can be taken of coasting periods, station stops, &c., to secure economy by putting the engine out of service. Excessive overload currents and overloading of the engine are avoided by the arrangement of the generator windings and the method of controlling the excitation. At the same time, however, the full power output of the generator is automatically maintained over a very wide range of train speed. There is no need for the driver to watch instruments while driving. A set of signals, consisting of two red and two white lights in the driving cab of the rail coach and trailer, serve to indicate whether there is adequate lubricating oil pressure and correct water circulation. In the event of failure of either of these services, the red light glows and gives the driver immediate warning. The red lights also glow when the engine is shut down, so that if the driver is stationed at the trailing end of the car or is driving from a trailer coach he has no difficulty in ascertaining whether the engine is at work.

By the courtesy and co-operation of the L.M.S. Railway, the rail car is being tested under service conditions on various portions of the company's system. In the first instance runs were made on the Warwick–Daventry–Northampton branch, on which the car ran as a single unit or with trailing loads of cattle trucks, horse-boxes, &c., as required. Although oil-electric vehicles are available twenty-three hours per day, the present running arrangements are made to suit the company's requirements and to work in with existing time-tables, and on the named branch the car has been in service fifteen hours per day and five days per week. During the five weeks ending November 11th, the vehicle ran 5880 miles at an average fuel consumption of 6·26 miles per gallon or 5·22 miles per gallon, including the heating boiler fuel, which works out at 0·5 gallon per hour for coach service. The figures include mileage and running time expended in shunting at wayside stations, shed movements, and other incidental running. The table below gives the results obtained during the period mentioned in greater detail.

Date, week ending.	Solo miles.	With trailer, miles.	Total miles.	Approx. total ton/miles.	Fuel oil engine, gallons.	Fuel oil boiler, gallons.	Total gallons.	Engine fuel miles per gallon.	All fuel miles per gallon.	Eng. fuel, lb./ton-miles.
14/10/33	1,014	146	1,160	48,270	193·0	44·0	237·0	6·00	4·90	0·0356
21/10/33	995	168	1,163	48,664	198·4	38·0	236·4	5·85	4·92	0·0360
28/10/33	1,094	129	1,223	45,020	183·8	34·25	218·05	6·65	5·60	0·0360
4/11/33	997	173	1,170	42,200	182·8	31	213·8	6·4	5·46	0·0380
11/11/33	1,021	142	1,163	42,540	181·9	39·5	221·4	6·4	5·30	0·0375

As we have said, at the present time the coach coupled to a standard trailer equipped with a driving end is working on the Watford–St. Albans service. Steps taken to avoid the transference of noise and vibration from the engine compartment to the passengers' compartments, as the result of this service running, have, we are informed, proved entirely successful. Smooth acceleration and good riding qualities have been secured, and passengers travel in comfort.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MULTIPLE MARINE OIL ENGINES.

Sir,—I read with interest your report in last issue of Mr. Ricardo's paper in which he advocates small engines for marine propulsion. This proposal to use many small engines instead of one large one raises arguments for and against, and a few points might be of interest. Engines of similar design, over any range of sizes, if run at their maximum speeds, consistent with safety from damage by inertia stress or centrifugal forces, will not have the same r.p.m., but will naturally have the same piston speed as one another. It follows from this that the work per minute done in a cylinder of each is in proportion to its cross-sectional area—that is, the horse-power increases in proportion to (cylinder diameter)^2. But the engine weight increases in proportion to (cylinder diameter)^3. Therefore,

$$\frac{\text{Engine weight}}{\text{Horse-power}} = \frac{(\text{dia.})^3}{(\text{dia.})^2} = \text{dia.}$$

That is, Weight *per horse-power* is increased in direct proportion to cylinder diameter in engines of similar design.

From this we can reasonably assume that a power installation having engines of 4ft. stroke will have its total engine weight twelve times that of an installation having the same total horse-power by engines of 4in. stroke. If these engines are direct-coupled to dynamos, the same argument might be applied to engine and dynamo combined.

So far the small engine has the best case.

The question next would be how much everything else increases in weight as engine size is reduced, also how the complication is added to.

Finally, large Diesel engines operating with air blast injection are suited to, and have time in their slow revolution to, consume the crudest fuel, while the small engine requires a distillate fuel and has hardly time to consume that properly in its quick revolution.

The real solution might possibly be found in using engines of 12in. or 15in. diameter cylinder bores, of full Diesel type with air blast, which are not exacting in fuel quality, and of which ten six-cylinder engines should give a total of 6000 horse-power, with a sensible engine-room.

December 13th. JAMES A. NEILSON.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

LECLANCHE-TYPE PRIMARY CELLS.

No. 397—1933. The first edition of the B.S. specification for Leclanché-type primary cells was published in 1930, and was immediately adopted by all the large purchasers of cells. Seldom has a specification been so widely quoted by purchasers, and worked to by manufacturers in so short a time. The experience thereby gained has enabled extensive data to be collected and a revision to be undertaken. The second edition differs from the first in two main respects. An alternative electrolyte to ammonium chloride is now provided, this being a mixture of zinc chloride and ammonium chloride in certain specified proportions. It is claimed that this mixture has the advantage that the cells keep cleaner in use, the amount of crystalisation round the terminals of wet cells being appreciably reduced. The second main feature of the new edition is that, as regards the majority of the cells, the watt-hour outputs have been considerably increased, this having been made possible by the improvements in manufacturing technique that have been developed during the last two or three years, no doubt brought about by the very keen competition in this branch of the industry. A new method of testing has been introduced for the small-unit cells used for radio high-tension and grid bias batteries, pocket torches, &c., this being a light intermittent discharge through constant resistance.

A chart summarising all the dimensions, watt-hour outputs and test conditions, is given as an appendix. It can be detached from the specification and mounted in a convenient position for reference purposes in the test-room.

RELAYS FOR SIGNALLING.

Nos. 519 and 520—1933. These are the third and fourth specifications in the series of B.S. Specifications for Relays for Railway Signalling Purposes. These are No. 519, Tractive Armature D.C. Neutral-polar Line Relays, and No. 520, Alternating-current Track Relays. Further specifications in the series are at present under consideration.

These specifications are an endeavour to co-ordinate the rather diverse specifications which have hitherto been used by the various railway companies. Special features have in the past been called for, without, in many cases, due consideration being given to the possibility that these features merely add to the cost of the relay without any commensurate practical advantage being obtained. For example, some railways have considered it necessary to carry a number of different types of track relays to meet their requirements, whereas other railways have found it possible, and advantageous, to use a single type of relay for almost every conceivable kind of track circuit. All the British railway companies were represented on the Committee responsible for these specifications, and although non-standard relays will for some time to come be called for in certain cases, it is hoped that more and more uniformity will gradually be secured by the adoption of the standard specifications.

MR. J. D. DALLAS.—Mr. J. D. Dallas, chief mains engineer of the County of London Electric Supply Company, Ltd., is retiring at the end of the year, though his services will be retained in a consultative capacity. On Thursday evening, December 14th, a dinner was given to him at the St. Stephen's Club by a large number of the chief officials of the company, when he was presented with a gold cigarette case as a mark of the esteem and affection with which he is regarded.

WANDLE VALLEY SEWAGE DISPOSAL WORKS.—The contractors for the Wandle Valley sewage disposal works, described in last week's issue, included the following firms:—Structural work, William Moss and Sons, Ltd., Loughborough; filtering material, Hibberts, Ltd., Battersea, S.W.11; sludge pressing plant, Manlove, Alliot and Co., Ltd., Nottingham; sewage screening plant, S. S. Stott and Co., Manchester; flume recorder for storm water, the Lea Recorder Company, Ltd., Manchester; Venturi recorders for sewage, George Kent, Ltd., Luton; pumping plant, Pulsometer Engineering Company, Ltd., Reading; sewage distributors, Hartley, Sons and Co., Stoke-on-Trent.

Heat Transfer Between Metal Pipes and a Stream of Air.*

By EZER GRIFFITHS, D.Sc., F.R.S. and J. H. AWBERY, B.A. B.Sc.

Introduction.—When a stream of air has to be heated or cooled it is the common practice to pass the stream over the surface of a bank of piping through which is circulating a hot or a cold fluid. For cold storage work the cooling medium may be brine or a refrigerant such as ammonia, whilst for heating installations steam or hot water is used. The technical importance of data of the design of such appliances has resulted in a very large number of investigations being carried out in this field. All the earlier workers who attempted accurate measurements concerned themselves with observations of heat transfer between the fluid inside and that outside the pipe, thereby obtaining the total resistance to the heat flow. This coefficient is a complex one, for it is built up of the surface resistance between fluid and solid at each side of the dividing wall, as well as the resistance of the material of the wall. Recent workers on the subject, following Stanton, have tended towards a simplification of the problem by making a study of each of the fluid-solid resistances separately. The resistance of the wall itself can usually be calculated from a knowledge of the conductivity of the material, and so does not require independent measurement.

In the investigation now to be described, the authors have devoted attention solely to the transfer between the external surface of a pipe, usually constituting one of a bank, and the stream of air sweeping past, the transfer being reversed in direction according as the pipe is hotter or colder than the air. The data were required in the design of air cooling batteries for refrigeration work, but the conclusions arrived at are of general application in the design of heat transfer equipment.

Scope of the Experiments.—As stated above, a study has been made of pipes hotter than the air and of those colder than the air. In the latter case under certain conditions a layer of ice or snow forms on the surface. The greater part of the work has been concentrated on the study of pipes when arranged in banks, the individual pipes which constitute the bank being placed transverse to the air stream. It was not deemed necessary to study banks of piping when the axes of the pipes were parallel to the air stream, since a single longitudinal pipe should give the required information. When the pipe under study was longitudinal with the air stream, the successive elements of the pipe, starting from the point of contact of the air, were dealt with independently. A certain amount of attention was given to single pipes placed transverse to the stream, as this particular case had received study by numerous investigators in the past.

The pipe temperatures have ranged from about 90 deg. Cent. down to a few degrees below the freezing point of water, and the velocity of the air stream from about 30ft. per second (*i.e.*, 20 m.p.h.) down to free convection.

Description of the Wind Tunnel.—The experiments were made with the pipes installed in a closed circuit wind tunnel, shown in Fig. 1. The cross section of the tunnel was 2ft. high by 3ft. wide. A closed circuit type of tunnel was adopted because it was necessary to control the temperature and humidity of the circulating air. The working section of the tunnel was the upper one and was 4·5ft. in length. The air stream was maintained by an air screw coupled to a 5 H.P. motor of variable speed. The air from the screw was discharged into the lower section of the tunnel which contained the cooling coils, and, in addition, a heater for conditioning the air before it was delivered to the bank of piping under test in the upper section.

For adjustment of the humidity, trays of calcium chloride or water were inserted in the lower section of the tunnel. At the junction of the upper and lower sections, baffle plates were installed to ensure uniformity in the distribution of the air flow over the working section. As in all other tunnels, there was some degree of turbulence in the air stream.

The air velocity was measured by means of a Pitot tube and Chattock gauge. The Pitot head was generally situated a few inches in front of the pipe or the bank under test. Since the velocity is moderately uniform over the central area of the tunnel, it is immaterial where the actual measurement is made, provided it is in the neighbourhood of the pipe. When banks of pipes were under study the velocity was taken upstream from the bank at three or more vertical heights so selected as to give the correct mean.

Measurement of the Quantity of Heat.—The quantity of heat transferred from pipe to air or air to pipe was determined by two alternative methods:—(1) The dissipation of electrical energy in a heating coil; or (2) the change in temperature of a stream of liquid circulating in the pipe. The electrical method was applicable only in the case when the pipe was hotter than the air, whereas the circulating liquid was available when the pipe was hotter or colder than the air. The electrical method was the more convenient of the two.

The construction of an electrically heated pipe is illustrated in Fig. 2. A sheet of thin "micanite" was sprung into contact with the internal surface of the pipe, and the heater was made by winding "nichrome" strip longitudinally on the outside of a split ebonite tube, which, in turn, was sprung into contact with the micanite sheet.

When circulating liquid was used, two methods of construction were employed at different stages of the work. In the first, the liquid circulated through two spirals of small-bore tubing soldered to the internal surface of the pipe. The two spirals were wound together with their inlets at opposite ends of the pipe. Hence the gradient in temperature in the one due to the liquid flow was in the reverse direction to that in the other, so that the average temperature at any point would be constant along the length. Good thermal contact between the pipe and the spirals was secured by first soldering the spirals on the external surface of a pipe of smaller diameter than the experimental pipe, then inserting it into the latter, and filling the interspace with solder.

The other method of construction was to make a wooden plug which was a good fit in the pipe. This plug had longitudinal grooves cut in the surface, so that the oil circulated to and fro along the length of the pipe in contact with the internal surface. The details of the construction will be understood from Fig. 3. It might be anticipated that the longitudinal groove method of construction would result in a model having temperature variations along the length. Provided the liquid was flowing fairly rapidly so that it did not suffer a large temperature rise, the variations were found to be small.

With the circulating fluid type of model, a correction has to be taken into account for the work done in forcing the liquid through the pipe. To obtain this correction all that is necessary is to measure the pressure drop in the liquid as it passes through the model. The heat energy dissipated in overcoming this pressure is then equal to the mechanical energy lost, given by the product of pressure fall and rate of flow.

A tank containing a mixture of paraffin and lubricating oil was cooled by the spiral coil evaporator forming part of a refrigerating plant circuit. The temperature of this oil was maintained at the desired value by thermostatic control, using an immersion heater. The oil from the tank was pumped through the model whilst a glass vessel of known capacity was inserted in a by-pass in the return circuit. This was used to determine the rate of flow without altering the resistance of the circuit or allowing the oil to come into contact with the room atmosphere.

The temperature rise in the circulating liquid was measured by means of a five-way differential thermo-element, shown in Fig. 3. This thermo-element had an E.M.F. of about 200 microvolts per degree.

In the experiments on banks of pipes set transverse to the air stream, the pipes, whether heated electrically or by liquid circulation, were made 2ft. in length. Wooden extension pieces of the same diameter as the pipe were provided at each end. These extensions were 6in. in length, so that they just reached the side walls of the wind tunnel. By this arrangement the length of pipe under test was kept well within that portion of the air stream which had a uniform velocity. At the same time, those disturbances of the air flow were avoided which would arise if the pipes did not extend right aross the tunnel. This procedure did, however, introduce a source of heat loss or gain to the pipe which had to be allowed for, on account of the flow between the ends of the pipe and the wooden extension pieces. The magnitude of this correction was evaluated in the case of the electrically heated pipes by constructing a similar model to the normal ones, but with a 12in. length of wood replacing the centre 12in. of the model. Then if the heat loss per foot run from the metal pipe is H_1 and the flow from the pipe into one end piece is H_2, for a normal pipe the loss is $2\,H_1+2\,H_2$, since the pipe is 2ft. in length. For the special model, the heat loss is $H_1+4\,H_2$. By subtracting the former from twice the latter, a quantity is obtained which is three times the loss from a pair of ends, *i.e.*, three times the correction to be applied in an experiment with a normal pipe. For the pipe with liquid circulation the end correction was evaluated by making a comparison with an electrically heated pipe when both were swathed with cotton wool, in order to make the end loss as large a fraction as possible of the total.

Determination of the Specific Heat of the Oil.—In the experiments using pipes with liquid circulation, it was necessary to determine the specific heat of the oil used as the circulating medium. Two methods were used. At temperatures above the dew point of the air in the room, the usual calorimetric method was applicable, electrical energy being dissipated in a coil immersed in a quantity of oil and the temperature rise due to the heat input being measured. The heat capacity of the calorimeter and accessories was determined by carrying out a similar experiment using water in place of the oil.

In the other method the experimental pipe was utilised as a continuous flow calorimeter. A coil of nichrome wire was wound on the pipe and the whole lagged heavily with cotton wool. The pipe was then maintained cold by circulating oil through it and the temperature rise of the oil for various values of energy dissipated in the heating coil was measured. Experiments by this method at a mean temperature of −6 deg. Cent. gave a specific heat of 0·38 calorie per cubic centimetre per degree Centigrade for the oil mixture employed, whilst similar experiments at a temperature of +36 deg. Cent. gave 0·41 and 0·42 for the specific heat. The value at 16 deg. Cent., obtained by interpolation from these figures, is 0·40, and this is in good agreement with the value 0·394 found by experiments using the first method described above.

Measurement of the Temperature of the Surface of the Pipe.—The temperature of the pipe surface was obtained by means of copper-constantan thermo-elements. At the appropriate spot, plugs of copper and of constantan were riveted into the pipe surface and the tops of these filed off flush with the surface. Holes were drilled in the centres of these plugs and the copper and constantan wires attached by driving in taper plugs. The large area of contact between the plugs and the pipe ensured that the heat conduction along the leads did not cool the junction appreciably. As a general rule, five thermo-elements were used on each pipe under test, these being distributed equally along the length and arranged in spiral formation so as to give the temperature at points spaced around the circumference of the pipe.

[Here the authors proceed to present the results obtained from single pipes placed transversely to the air flow. Their method of presentation is founded on the principle of similitude. After considering various alternative possibilities from the point of view of dimensional theory, they deduce that $H/k\,\theta$ is a function of $V\,d/\nu$ and θ/θ_0, where H is the heat loss per unit time per unit length of pipe, k is the thermal conductivity of air, θ is the temperature excess (that is to say, the difference between the temperature of the air and that of the surface of the pipe), θ_0 is the temperature of the air, V is the velocity of the air, d is the external diameter of the pipe, and ν is the kinematic coefficient of viscosity of the air. Experiment, they say, shows that the effect of the variable θ/θ_0 is negligible. From this theoretical basis they ultimately develop the formula

$$H=V^{\frac{1}{2}}\,\theta\,(0{\cdot}36+0{\cdot}50\,d),$$

where H is the heat loss in B.Th.U. per foot run per hour, V the velocity of the air in feet per second, and θ is the temperature excess in degrees Centigrade. This formula, it is emphasised, is empirical, in spite of the theoretical considerations which led the authors to its establishment, and may not be applicable outside the range of their experiments. Nevertheless, it reproduces with fair accuracy the experimental figures obtained by the authors with single copper pipes of from 1¼in. to 3in. diameter, and with a single iron pipe, 1⅞in. in diameter.]

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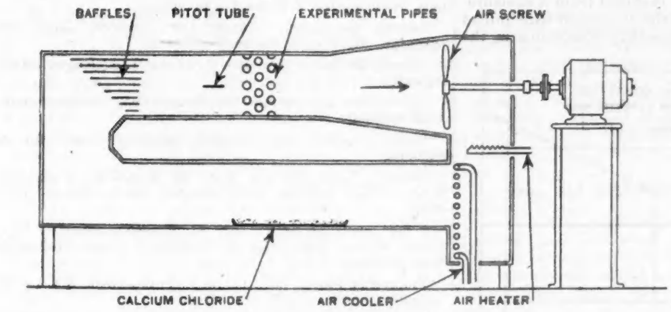
* The Institution of Mechanical Engineers. Abridged.



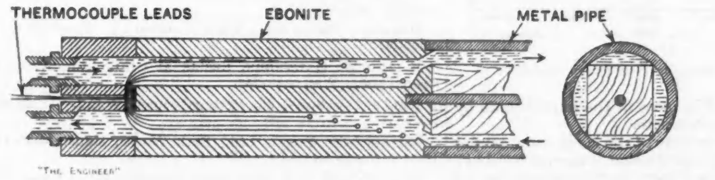
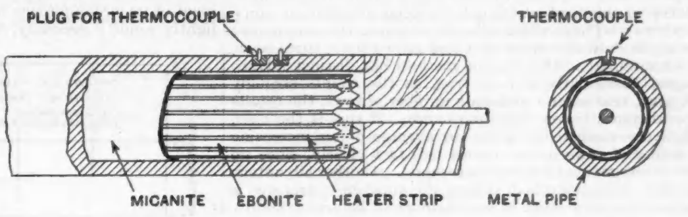


FIG. 1 (*Above*)—*Section Through Wind Tunnel.*
FIG. 3 (*Below*)—*Construction of Pipe for Liquid Circulation Method of Measuring Quantity of Heat.*



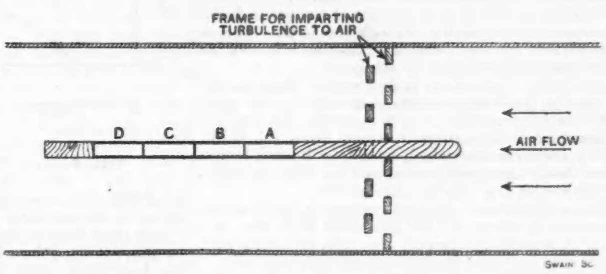


FIG. 2 (*Above*)—*Construction of Pipe for Electrical Method of Measuring Quantity of Heat.*
FIG. 4 (*Below*)—*Longitudinal Pipe in Tunnel.*

Pipe with Axis Lying Along the Air Stream.—A considerable number of the batteries for air cooling in use at the present day are of the longitudinal type. In these, the air stream flows through the battery in a direction parallel to the length of the pipes. Generally, the distance between the pipes is such that the section of the air stream associated with any one pipe is not affected by the presence of the adjacent pipes. Hence there is no necessity to study banks of piping when longitudinal formation is under consideration and a single pipe will give the essential information.

From general considerations it would be expected that the heat transfer coefficient would vary considerably from point to point along the pipe. The experimental model used for this work was therefore made with four separate 6in. sections, each having its own independently controlled electrical heater. To prevent heat conduction from one section to another, these were separated by wooden discs about ⅛in. thick, and the currents in the various sections were adjusted so that adjacent ends of different sections were at the same temperature. In consequence of the decreasing heat transfer, the temperature rose when proceeding downstream along any one section, so that the next section had to be at a higher mean temperature than the preceding one.

Upstream from the first section A, the model—Fig. 4—was provided with a fairing of wood, about 18in. long, having a hemispherical nose, so that the air should be flowing smoothly when it met the first heated section. The model was also prolonged by about 6in. of wood, made to extend beyond section D, so as to continue the flow pattern of the air to a point well away from the sections studied. The small heat flow into these wooden end sections was allowed for by calculation. Three thermocouples were pegged into each section and the effective temperature of the section was taken to be the mean of those given by the three.

The results found for section A are much higher than those for the later sections, and, furthermore, it is impossible to distinguish the points for sections C and D when the data are plotted on a graph. The ratio of the heat transfer coefficient for a transverse pipe to that for a longitudinal one varies with the section taken, and also with the Reynolds number at which the comparison is made, but it may be worth noting that the efficiency of the transverse pipe is of the order of twice that of a longitudinal one.

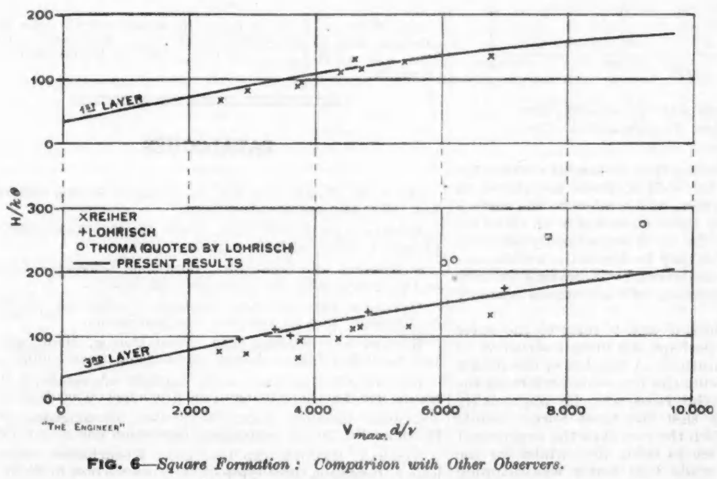


FIG. 6—*Square Formation: Comparison with Other Observers.*

Effect of Turbulence.—With a view to studying the increase in heat transmission due to a turbulent air stream, a state of eddy motion was set up by a framework of horizontal wooden laths placed in the wind tunnel, at a point between the baffles and the working sections of the longitudinal pipe, the general lay-out being seen in Fig. 4. The velocity observations were made in the space before the point where the air met the wooden fairing in the undisturbed part of the air stream. The greatest effect is in section A, for which the heat transfer is more than doubled. For section B, which initially had a smaller coefficient than section A, the increase is somewhat less than twofold, so that the disparity is increased. Similarly, sections C and D suffer still smaller increases. Although they had initially the same heat loss, yet in turbulent air section C loses more heat than D. The results, both with and without artificially induced turbulence, are consistent with the suggestion that the air, in travelling along the pipe, settles down to a constant state, and that increased turbulence tends to augment the heat loss.

Heat Transmission of a Pipe Constituting an Element in a Bank.—An important practical case occurs in pipes arranged in banks, the individual pipes having their axes transverse to the air stream. The number of different configurations which could be studied under this heading is almost unlimited, whilst theory gives practically no assistance in transferring the results obtained with one formation to that of any other.

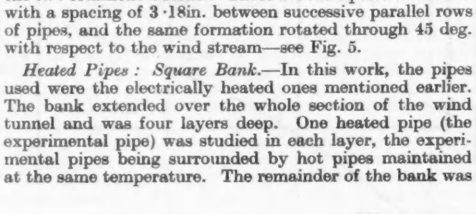


FIG. 5—*Formation of Banks.*

To keep the investigation within reasonable bounds, work on banks of pipes has therefore been restricted to the use of pipes of a diameter commonly used in refrigeration work, nominally 1$\frac{23}{32}$in. externally, built into banks of the two commonest forms. These are the square formation with a spacing of 3·18in. between successive parallel rows of pipes, and the same formation rotated through 45 deg. with respect to the wind stream—see Fig. 5.

Heated Pipes: Square Bank.—In this work, the pipes used were the electrically heated ones mentioned earlier. The bank extended over the whole section of the wind tunnel and was four layers deep. One heated pipe (the experimental pipe) was studied in each layer, the experimental pipes being surrounded by hot pipes maintained at the same temperature. The remainder of the bank was filled up with wooden dummies of the same diameter as the heated pipes.

The pipes were maintained at a series of steady temperatures and the energy dissipated in the heating coils measured for each excess temperature. The air speed was measured by means of a Pitot and static tube, which was traversed on the centre vertical line, about 15in. upstream from the first layer of pipes. In calculating the temperature excess for a pipe in a layer beyond the first, the air temperature is that prevailing at the later layer, and not the initial air temperature.

The results are most conveniently exhibited, as in Fig. 6, by plotting the two dimensionless variables $H/k\theta$ and Vd/ν. Not only does this method of representation enable the results to be applied to banks of the same form on a different scale, but it permits of heat transfer figures being taken for design purposes at any desired air temperature. For convenience in calculating heat quantities for any particular set of conditions from the curves, a table of values of ν and of k is inserted here:—

TABLE I.—*Kinematic Viscosity and Thermal Conductivity of Air.*

Mean temperature, deg. Cent.	Kinematic viscosity ν, C.G.S. units.	Thermal conductivity $k \times 10^5$, C.G.S.-calorie units.
—10	0·122	5·10
—5	0·127	5·25
0	0·132	5·32
5	0·136	5·40
10	0·140	5·48
15	0·145	5·56
20	0·150	5·64
25	0·155	5·71
30	0·159	5·78
35	0·164	5·85
40	0·169	5·93
45	0·174	6·00
50	0·179	6·08
55	0·184	6·15
60	0·190	6·23

The smoothed results taken from these curves are set out in Table II. below. In all cases, the actual observed heat transfer, corrected for the loss at the wooden ends of the experimental pipe, but not corrected for radiation, has been used. C.G.S. units are used throughout, but since both variables are dimensionless, any consistent set of units may be used with the figures.

TABLE II.—*Heat Transfer from Pipes in Square Array (Generalised Units).*

$\frac{Vd}{\nu}$	$H/k\theta$ (smoothed values).		
	Front layer.	Second layer.	Third layer.
0	49	49	49
2,000	115	128	128
4,000	168	195	195
6,000	216	259	259
8,000	261	320	320
10,000	307	382	382
12,000	343	441	442
14,000	377	494	494

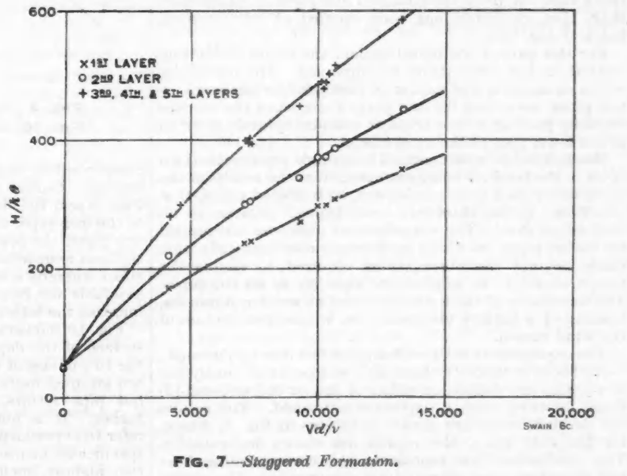


FIG. 7—*Staggered Formation.*

It will be seen from Table II. that the heat loss from a pipe in still air is independent of its position in the bank, and also that the loss in moving air increases a few per cent. in passing from the first layer to the second, but that this increase does not continue to the third layer. The most probable explanation is that eddies are either set up or increased in the air as it passes through the first layer, but that a steady regime is then reached. This evidence that eddy motion increases the heat transfer is not surprising, although it could not be predicted *a priori* what the extent of the increase would be.

Comparison of Results for Square Formation with those of Other Observers.—Table II. shows the heat loss from a pipe in each vertical row treated as an individual unit. Other methods of plotting have been adopted by some authors who have studied banks of pipes, the commonest being to show the mean heat loss in two rows, three rows, four rows, &c. The present method has distinct advantages, particularly if it is true, as the results strongly suggest, that after a moderate number of rows, the results for all pipes lie on the same curve. If this is the case, then the method of taking an average of an increasing number of rows never reveals this fact clearly, since no two averages ever become quite equal. Another advantage of the present method is that the total heat transfer is calculable for a bank of any number of layers by simply adding together the transfers for the individual layers. All that is necessary is to take account of the gradual rise in air temperature in passing through the bank. This is easily calculated, since the mass of air flowing is known, as well as the heat imparted to it in each layer.

It should also be noted, as stated earlier, that the air velocity used in these experiments in calculating the value of the Reynolds number ($V\,d/\nu$) is normally the velocity in the unimpeded air current upstream from the bank. This is the only velocity which would be known before hand when designing a bank, and indeed the only one which is measurable with any ease in actual practice.

No other authors have reported results for banks which are geometrically similar to the ones dealt with here, but it may be of interest to compare the present results with those published for other banks of square formation.†

Results for "Diagonal" or "Staggered" Formation.—The formation studied consisted of iron pipes of external diameter, $1\frac{23}{32}$in., arranged as in Fig. 5. Five layers in all were studied, this involving a bank of six layers so as to avoid anomalous conditions in the last one utilised. As before, the velocity was measured in the unobstructed air stream before it reached the bank of pipes, and the pipes were electrically heated. The results show a systematic increase in the heat loss in successive layers up to the third, after which it remains constant. A typical set of values of $H/k\,\theta$ at a fixed Reynolds number of 7220 is as follows:—

First layer.	Second layer.	Third layer.	Fourth layer.	Fifth layer.
243	302	394	400	397

Manifestly the experimental points for the last three layers cannot be plotted on one diagram without confusion, so that in Fig. 7 only the mean results for the last three layers are given. This figure shows the whole of the experimental results for this formation, when the pipes were hotter than the air The results found for the staggered formation suggest, even more than those for the square formation, that the air is set in a definite state of eddy motion in the first layer, and that the second layer adds to the general turbulence, the process being completed after the third layer. Similar results have been previously reported, in particular by Reiher in his study of single pipes. He succeeded in increasing the heat transfer by about 50 per cent. when the air falling on one of his pipes was first passed through a grid of piping to induce eddy motion.

It was considered of interest to examine the corresponding case when the air falling on the bank of pipes was artificially made turbulent. For this purpose the framework of wooden laths described previously was placed in the path of the air after it left the baffles at the entrance to the working section of the wind tunnel. The heat transfer in this case was very considerably augmented, and it is possible that the limit of increase in turbulence of the air stream was practically reached, since the second row lost hardly more heat than the first under these conditions. For each of them the heat transfer was greater when the framework was present than it was for the last layers in the absence of the framework. The effect due to the presence of the framework represents an increase of about 100 per cent. for the first layer and about 50 per cent. for the second.

Pipes below 0 deg. Cent.: Staggered Formation.—The diagonal formation of transverse pipes, besides being the one which shows the highest efficiency, is also the one commonly used in refrigeration practice. Consequently, this formation, using the standard iron pipes of rather more than $1\frac{7}{8}$in. diameter, has been studied at temperatures below 0 deg. Cent.

For this part of the investigation, the liquid circulation method had of necessity to be employed. The remainder of the equipment was similar to that used for the work on hot pipes, save that for one part of the work the air was dried by passing it over trays of calcium chloride inserted in the lower part of the wind tunnel.

Measurements were confined to a single pipe in the third layer of the bank, it being assumed, from the results of the work which had been carried out with heated pipes, that conditions in the third row were typical of those in all succeeding rows. The experimental pipe was surrounded by cooled pipes on which no thermal measurements were made beyond the observations required to enable the temperatures to be adjusted to equality in all the pipes. The remainder of the bank consisted of wooden dummies, making up a battery occupying the whole cross section of the wind tunnel.

The experiments with cooled pipes fall into two groups:—(1) Those in which the humidity was kept sufficiently low to prevent any deposition either of dew or of frost, and (2) those in which such a deposit was formed. The results for the first group are shown as crosses in Fig. 8, where, for the cold pipes, the results are shown individually. The continuous line represents the corresponding heat loss from hot pipes as measured electrically. The circles represent a few further observations made on hot pipes by the liquid circulation method. They serve to illustrate the order of agreement between the results obtained by the two methods.

When it is remembered that radiation is somewhat less at the lower mean temperatures, the results shown in Fig. 8 justify the conclusion that, within experimental error, a change in the direction of the heat transfer alters only the sign of $H/k\,\theta$, and not its actual magnitude.

In the experiments in which a snow or ice deposit was formed, two additional measurements were made. First, the thickness of the deposit was deduced from a measurement of its circumference by means of a paper tape pulled lightly round; secondly, the humidity conditions in the wind tunnel were recorded in most of the experiments by means of an Assmann psychrometer.

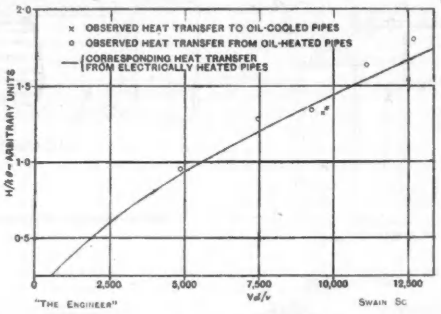
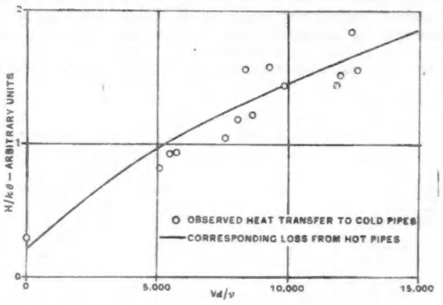


FIG. 8—*Heat Transfer for Dry Pipes (Cold).*

It is clear that the temperature of the ice or snow cannot be above 0 deg. Cent., and equally that it cannot be above the hoar frost point, since otherwise the deposit would not form. If it is below the hoar frost point, then the deposit will continue to build up, and will increase in thickness until this temperature is reached at the outer surface. In equilibrium, the temperature of the latter must therefore always be either 0 deg. Cent. or the hoar frost temperature, whichever is lower, whereas it will be below the stated value if equilibrium has not been reached.

The dimensionless variables may be tabulated in two ways. First, the measured temperature of the pipe surface may be used in the formula $H/k\,\theta$, the external diameter of the pipe itself being then used in the corresponding formula $V\,d/\nu$. Secondly, the estimated temperature of the outside of the ice or snow deposit may be used, the corresponding value of *d* being that measured outside the deposit. Curves plotted by both methods are shown in Figs. 9 and 10. In the former, which refers to the surface of the iron pipe, the results agree quite well with those for dry pipes, the presence of the ice or snow hardly affecting the heat transmission. This may be due to the well-known effect whereby a layer of insulation, by increasing the area available for heat transmission, will sometimes actually increase the latter.



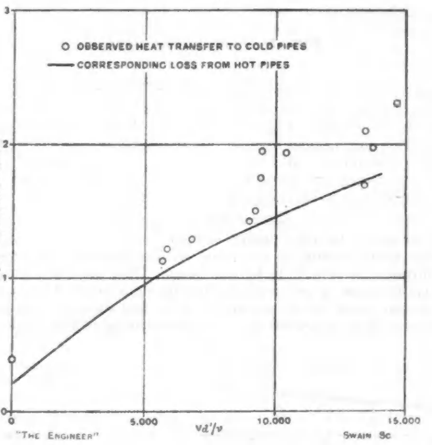


FIG. 9 (*Above*)—*Heat Transfer to Cold Pipes.*
FIG. 10 (*Below*)—*Heat Transfer to Cold Pipes.*

Fig. 10, however, in which d' and θ' refer to the outer surface of the deposit, is perhaps the more instructive of the two modes of representation. A number of the results are grouped quite well about the line which refers to the hot pipe results, whilst the remainder lie appreciably higher. It is noteworthy that the three lowest results refer to experiments in which the record of the experiment specifically mentions the ice as being dry, whilst for the two highest, mention is made that water was dripping from the pipe. This water in condensing from the atmosphere would liberate a considerable amount of latent heat, and evidently this is the cause of the high rate of heat transfer. It is clearly desirable in practice to aim at this condition, which can increase the heat transfer by about 30 per cent., *i.e.*, an increase which would require 50 per cent. increase in air velocity to attain.

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† This comparison is exhibited in Fig. 6, but the original paper should be consulted for information concerning the extent to which the different investigators' figures are really comparable.—Ed., The E.

CALENDARS, DIARIES, &c.

Associated British Machine Tool Makers, Ltd., 17, Grosvenor-gardens, S.W.1.—Wall calendar, with monthly tear-off sheets.

Baird, William, and Son, Ltd., Anniesland, Glasgow.—Wall calendar, with monthly tear-off sheets.

Braithwaite and Co., Engineers, Ltd., Broadway Buildings, Westminster, S.W.1.—Pocket diary.

British Insulated Cables, Ltd., Prescot, Lancs.—Wall calendar. Refill cards for desk calendar.

British Thomson-Houston Company, Ltd., Rugby.—Greeting card.

Cleveland Institution of Engineers, Middlesbrough.—Wall calendar.

Demag, Aktiengesellschaft, Duisburg.—Refill for desk calendar.

Dorman, Long and Co., Ltd., 55, Broadway, Westminster, S.W.1.—Desk calendar, with monthly tear-off sheets. Pocket diary.

"The Draughtsman," 96, St. George's-square, S.W.1.—Diary of the Association of Engineering and Shipbuilding Draughtsmen.

Fleetway Press, Ltd., 11–15, Emerald-street, W.C.1.—Wall calendars, with monthly tear-off sheets.

Greenwood and Batley, Ltd., Leeds.—Wall calendar, with monthly tear-off sheets.

Holman Brothers, Ltd., Camborne, Cornwall.—Art calendar.

R. and W. Hawthorn, Leslie and Co., Ltd., Newcastle-upon-Tyne.—Wall calendar.

Kelly and Sons, 26, Portugal-street, W.C.2.—Desk diary for 1934.

Mather and Platt, Ltd., Park Works, Manchester, 10.—Date engagement pad for 1934.

C. A. Parsons and Co., Ltd., Newcastle-upon-Tyne.—Wall calendar, with monthly tear-off sheets.

Robinson, Thomas, and Son, Ltd., Rochdale.—Wall calendar, with monthly tear-off sheets.

Ruston and Hornsby, Ltd., Lincoln.—Wall calendar, with monthly tear-off sheets.

Ruston Lister Marine Company, Ltd., Imperial House, 15, Kingsway, W.C.2.—Wall calendar, with monthly tear-off sheets.

Stanton Ironworks Company, Ltd., near Nottingham.—Pocket diary.

Staveley Coal and Iron Company, Ltd., near Chesterfield.—Diary.

Syren and Shipping, Ltd., 44–46, Leadenhall-street, E.C.3.—Copy the *International Mercantile Diary and Year Book*, 1934, price 10s. 6d.

G. and J. Weir, Ltd., Cathcart, Glasgow.—Greeting card.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. A. R. Cooper, chief engineer of the London Passenger Transport Board, has been unanimously elected chairman of the Civil Engineers' Committee of the Railway Clearing House for the year 1934.

Marshall, Sons and Co., Ltd., of Gainsborough, inform us that on and after January 1st, 1934, their offices will be at Brettenham House, Lancaster-place, Strand, London, W.C.2 (phone, Temple Bar 5792 and 5793).

Mr. E. W. Hudson, solicitor to the Electricity Commission since shortly after its inception in 1919, is severing his connection with Savoy-court as from January 1st. We understand that Mr. Hudson has found his combined work, on behalf of the Commission and the Ministry of Transport, too exacting, and that he intends to resume private practice.

Sir James Milne, C.S.I., general manager of the Great Western Railway, has been unanimously elected chairman of the Railway General Managers' Conference for the year 1934. Sir James, who has been general manager of the Great Western since 1929, was for a time Director of Statistics of the Ministry of Transport on the formation of the Ministry, but returned to the Great Western Company in 1922.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

Henry Robb, Ltd., of Leith, have received an order for a coasting barge to carry 125 tons of cargo. The vessel is to be fitted with a 2 H 4 type, 100 B.H.P. British Kromhout marine oil engine.

CATALOGUES.

Sir W. H. Bailey and Co., Ltd., Albion Works, Salford.—List 733 of coin-operated turnstiles.

Mather and Platt, Ltd., Park Works, Manchester.—A pamphlet dealing with the canning of peas.

S. Russell and Sons, Ltd., Bath-lane, Leicester.—Leaflets on the various alloy cast irons made by the firm.

Davidson and Co., Ltd., Belfast.—Publication S F 88 B., on "Aeroto" fans for auxiliary mine ventilation.

Holden and Brooke, Ltd., West Gorton, Manchester.—List No. 909 of "Quick Access" split casing design pumps.

Ruston and Hornsby, Ltd., Lincoln.—A catalogue illustrating and describing in detail the firm's fuel oil locomotives.

George Ellison, Ltd., Perry Bar, Birmingham, 20.—Brochure No. 204 on switchgear installation and maintenance.

Newman, Hender and Co., Ltd., Woodchester, Glos.—A leaflet illustrating three types of valve wheels now made by the firm.

James Beresford and Son, Ltd., Cato-street Works, Birmingham.—Lists describing "Beresford-Stork" centrifugal pumps.

Jointless Firebrick Company, Ltd., 170, Piccadilly, W.1.—A leaflet illustrating the "Plibrico" observation port for furnaces.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Import and Export Figures.

The Board of Trade import and export figures for November are again encouraging so far as the British iron and steel trades are concerned. The total imports of iron, steel, and manufactures thereof, increased from 88,854 tons in October, to 91,327 tons in November, whilst the exports were down a little to 184,391 tons in November, compared with 193,613 tons in October. For the eleven months ending November 30th, the imports totalled 880,856 tons, and the exports 1,750,399 tons. The imports of pig iron remained insignificant, amounting in all to 2185 tons of foundry iron, of which 1306 tons came from India, and 835 tons from Sweden. The imports of basic iron were 8090 tons, all of which came from India. It is interesting to note that the importation of semi-finished steel, such as blooms, billets, and slabs, after increasing for two months, declined in November to 21,308 tons from 28,511 tons in October. No doubt this was partly due to the restrictions of offers from the Continent. The principal suppliers of this material were Belgium, 12,473 tons, and France, 5583 tons. There was also a decline in the quantity of sheet bars imported, the figure for November being 7850 tons, compared with 8626 tons in October. The imports of beams, girders, and joists, after declining for two months, showed an increase in November to 6936 tons, compared with 4487 tons in October. The imports of hoop and strip, which had increased from 8668 tons in September to 9934 tons in October, fell in November to 7362 tons. On the export side the quantity of pig iron dispatched overseas reached 13,998 tons, which was a sharp increase over the October total of 7559 tons. The general exports of steel reached 108,132 tons, the largest buyers being India, 24,582 tons, and British South Africa, 11,526 tons. Exports of plates and sheets, not galvanised, reached 9547 tons, of which Canada took 1681 tons. The exports of plates and sheets under ⅛in. thick, totalled 10,005 tons, of which 2338 tons went to India, 1770 tons to Australia, and 1633 to the Argentine. The exports of galvanised sheets were disappointing, and reached only 23,461 tons ; but the exports of tin-plates were maintained at 40,435 tons. The total railway material exported in November was 9433 tons.

Machinery Exports.

The exports of machinery during November increased in tonnage, but declined slightly in value compared with October. The tonnage reached 27,937 tons, against 25,142 tons in October, whilst the value amounted to £2,482,702, compared with £2,509,603 in October. The exports of textile machinery amounted in value to £490,480, compared with £475,670 for the previous month. British India was the largest individual purchaser, taking goods to the value of £130,141. The exports to Germany were valued at £20,122, and to Holland at £22,329. The export of prime movers decreased in value during November to £255,230 from £266,577. Of this total the exports to India reached £33,711 ; those to South Africa £29,217, and to Australia £10,363. The value of the exports of machinery and parts thereof improved to £51,599, against £47,030 in October. Countries in Europe purchased to the value of £9872, and countries in America to £8179, the exports to British India amounting to £6143. Exports of machine tools for metal working showed a notable improvement in November to £101,983, compared with £74,625 in the previous month. The largest individual buyer was Soviet Russia, which purchased machinery to the value of £18,123, British India coming next with purchases to the value of £15,964. The exports to European countries, excluding Russia, amounted to £23,177. The export figures included also three steam vessels having a gross tonnage of 7949 tons, valued at £118,930, and eleven motor vessels of 699 tons gross, valued at £25,587.

The Pig Iron Market.

It is many years since the situation of the Cleveland pig iron producers was so favourable. In fact, something like a famine in foundry iron prevails in that district. The stocks in makers' hands are sold and the forward sales already made will absorb the current output for a month or two ahead. At the same time, the requirements of the market are increasing and so acute has the position become that local consumers have been obliged to import supplies of Northants iron. It is expected that the make of Cleveland foundry will be increased early in the New Year ; but so far there has been no announcement on this point. The attitude of the makers is somewhat puzzling and although there are buyers willing to contract for delivery as far forward as June, producers appear reluctant to enter into any engagement. This, it is thought, points to an increase in prices within the next few weeks ; but possibly the price for Cleveland will not be advanced until the makers in other districts are in a position to raise their prices. The demand for Midland irons is well maintained, but stocks have not been depleted to the same extent as on the North-East Coast. Nevertheless, the makers' position has improved sufficiently to enable them to adopt a rather stiff attitude to consumers. Most of the large buyers of Midland irons have covered their requirements, but there is a steady business passing in small tonnages for immediate delivery. The shortage of Cleveland iron has benefited makers in this district, and they have effected fair sales to consumers on the North-East Coast and increased the quantities dispatched to the Scottish light castings industry. The situation in the market for hematite has also become tight. The producers are well sold over the first few months of next year and stocks, which have been much reduced during the past month or two, are being drawn upon at an increasing rate. The stoppage of two furnaces at the Normanby Works was followed by the lighting of one at Consett. It is anticipated that another furnace will be put on to produce hematite early in January. Merchants hold fair quantities, but as an advance in prices is thought possible within the next few weeks, they are not prepared to accept lower figures than the makers. The position is not so good in Scotland, and some of the local make is being put into stock. The demand from the light castings industry is steady. Ten furnaces are in operation in Scotland, of which six are producing foundry, three hematite, and one basic.

Iron and Steel Production.

The great improvement in the situation in the British iron and steel trades is shown by the monthly statement of the National Federation of Iron and Steel Manufacturers on the production of iron and steel during November. At the end of the month seventy-nine furnaces were in blast, which was an increase of five since the beginning of November. Although the report does not give particulars of these five furnaces, two were put into operation by Dorman, Long and Co., Ltd., one by the Frodingham Iron and Steel Company, Ltd., one by the Darwen and Mostyn Iron Company, Ltd., and one by Alfred Hickman, Ltd. The production of pig iron in November amounted to 374,900 tons, compared with 373,300 tons in October, and 267,700 tons in November, 1932 ; the daily rate of operation thus showed an increase of nearly 4 per cent. between October and November. The production included 102,400 tons of hematite, 178,300 tons of basic, 77,600 tons of foundry, and 9600 tons of forge pig iron. The output of steel ingots and castings in November was 695,000 tons, compared with 668,300 tons in October, and 473,800 tons in November last year.

North-East Coast and Yorkshire.

Recently there has been a considerable increase in the output of finished steel materials on the North-East Coast, but so strong is the demand that it is expected fresh plant will be put into operation early in the New Year. The market takes a cheerful view of the position and there seems no anticipation of any decline in business beyond the usual fluctuations. The improved prospects in the shipbuilding industry and the expectation that fresh railway orders will be distributed in the New Year is the principal cause of this optimism ; but the strength of the current demand for sections, bars and structural material generally supports this view. Export business, although it has picked up a little lately, still lags, and the great bulk of the business transacted is on home account. The sheet mills are not so well employed as other branches of the industry ; but business with home consumers is steady. There has been no change in prices, but the quotations for some of the descriptions of uncontrolled steel material show a tendency to advance. In Yorkshire busy conditions rule in the iron and steel trades and an additional open-hearth steel furnace has been lighted at the Templeborough works of the United Steel Companies. This makes ten furnaces in commission at these works. The works producing axles, tires, and springs are busy and the demand for alloy and special steels is on a good scale. All the Sheffield re-rolling works are actively engaged, principally upon small bars and sections. A feature of the position is the strong pressure for immediate and near delivery. Recently business in boiler plates has expended, and the heavy engineering and electrical engineering industries are also taking good quantities of steel material.

Scotland and Lancashire.

The approach of the holidays has naturally caused some relaxation in the demand, but industrial operations have increased owing to the pressure of consumers to obtain deliveries before Christmas. It is not expected that the Scottish steel works will commence work upon materials required in connection with the recent shipbuilding and other contracts until after the holidays ; but the prospects of the industry have been greatly improved by the orders which have been given out recently. The certainty of work being re-started on the great Cunarder has naturally created a feeling of optimism in the steel industry, although most of the material needed for the completion of this vessel will consist of the lighter descriptions of steel. For the time being business in ship plates and sections is rather quiet. The amount of work received from structural engineers also is disappointing, and the tendency noticeable a few weeks ago for trading to expand in this branch has not been maintained. The tube works are busy on the Palestine pipe line order, which it is estimated will involve the use of from 5000 tons to 6000 tons of steel. The rail mills also are fairly busy on orders from China and India, and a contract has been secured for the supply of rolls for the new steel works in Pretoria. In Lancashire the steel industry is fairly well employed, but recently orders from the structural engineering shops have declined, although there are prospects of some improvement in this direction in the New Year. Similar anticipations are held by the plate manufacturers, who expect to benefit from the orders given out to the locomotive builders by the railways. The lighter sections of the trade are busy, and in some instances the works are operating almost at capacity. It is interesting to note that in this district little interest is shown in imported steel materials. Most users of bars, for instance, are still able to specify against contracts which were placed when the price for British re-rolled steel was much lower than to-day.

The Midlands.

Conditions in the Midlands reflect the approach of the holidays. The works are hastening to complete deliveries before closing down, and consumers are disinclined to place fresh business for the time being. There is no doubt that the works will enter the New Year with better order books than for many years past. The Midland constructional engineers, on the whole, are not busy, but there are a few exceptions to this rule. The sheet trade is well employed, principally upon the thinner gauges, and the works producing strip, in several instances, are behind hand in delivery, this being one of the best employed branches of the industry in the country. The re-rollers are also actively engaged upon the production of small bars, and business in this department seems likely to continue active right up to the commencement of the holidays. There has been no change in prices, the British works are still quoting £7 5s. to £7 10s. d/d, although there are more works asking the higher figure than was the case a week or two ago. Continental material is being offered at £6 10s. 6d. d/d, and if more orders are being placed with Continental sellers than has been the case for some months, the total volume of this business is not sufficient to cause the British makers anxiety. The steel works are quoting £7 15s. up to £8 5s. for bars, according to quality. Business in colliery steel still hangs fire somewhat, although it is increasing and prices are firmer. Similarly, purchases of bright drawn steel have fallen off, but this is scarcely surprising, considering the strong demand for this material during the past two months.

A South African Contract.

Tenders are being called for by the City Council of Pretoria for an important extension of the municipal power station. The object of this extension is to provide for the extra power which will be required to operate the national iron and steel works which have been established at Pretoria. These works are expected to begin operations within the next few weeks. The Iron and Steel Corporation will supply power from its own station, but it will draw a supplementary supply from the municipal station to meet the needs of a galvanised sheet works which it has been decided to establish in addition to the main steel works. The iron and steel works have been erected mainly by British contractors, and it is estimated that by the time the scheme is completed the capital expenditure will amount to £6,000,000. The intention is to manufacture 150,000 tons of steel per annum. The Town Clerk of Pretoria (Mr. M. G. Nicolson) and the City Electrical Engineer (Mr. L. L. Horrell) are on a visit to this country, and have been arranging the details of these power station extensions with Merz and McLellan, the Council's consulting engineers.

Copper and Tin.

It not infrequently happens that at the end of the year a sharp rise takes place in the prices of non-ferrous metals. This is partly due to consumers covering their requirements for the early part of the New Year, and perhaps to a certain amount of manipulation, since higher prices at the turn of the year give balance sheets a rather better appearance. This year, however, the movement seems to be a natural outcome of an increase in buying. The German consumers have purchased fair quantities, and in the United States also the demand has improved probably in the belief that the "code" will come into force in the New Year and prices will be automatically increased. The British users of copper have also shown more interest in the market. In America the price has increased to 8.25 c. to 8.37½ c., and the export price has advanced from 8c. to 8.25 c. to 8.37½ c., the sterling quotations ranging between £35 10s. and £37 c.i.f., according to the exchange. Business in the standard market has been better, and prices have advanced in sympathy with the electrolytic quotation, and a fair amount of speculative buying. . . . In the tin market there has been little change in values. Business has been quiet, and few transactions with the United States have occurred. European consumers also have shown only a slight interest in the market. It is suggested that the Pool has sold good quantities of tin to the United States, but the market there has not had an active appearance. In fact, the tin market seems to have settled down for the time being to rather uninteresting conditions, which will probably rule until well into the New Year. It is anticipated that there will be another decrease in the visible supply at the end of March.

Lead and Spelter.

Prices in the lead market have remained steady, but trading has been rather quieter than of late. Nevertheless, good quantities of lead are still passing into consumption. It is not expected that the strike at the Mount Isa Mine will last long, but this has had no influence upon the market. Some surprise was occasioned when it was found that the Australian shipment of lead to Europe during November was the largest for any month during the year, the total reaching 18,200 tons. The Burmese shipments were also fairly large at 5000 tons. It is obvious, therefore, that there is plenty of lead available for the market. The demand for lead in Germany is said to be improving, largely as a result of the public schemes which have been undertaken in that country. . . . In the spelter market prices, after showing some weakness, have developed a stronger tendency. Consumers have bought sparingly, but there has been a steady stream of business which augurs well for trade in the New Year. The statistical position seems to be improving, and the announcement of the renewal of the Cartel has been favourably received. The statement issued after the Cartel meeting last week that during November stocks had fallen by about 2000 tons, and that the total stocks were about 128,000 tons, or, roughly speaking, about two months' supply, disclosed a better position than the market had anticipated. If the Continental consumption increases in the New Year as seems to be expected, the position of this market should be materially strengthened.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
Midlands—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 0	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—

N.W. Coast—

Hematite Mixed Nos. ..
3 15 6 d/d Glasgow
4 0 6 „ Sheffield
4 5 6 „ Birmingham

(*Basic iron prices subject to a rebate of 5/-.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	6 17 6	—
Plates, ⅜in. (basis)	9 0 0	7 15 0
„ $\frac{5}{16}$in.	9 5 0	8 0 0
„ ¼in.	9 10 0	8 5 0
„ $\frac{3}{16}$in.	9 15 0	8 10 0
„ ⅛in.	9 7 6	8 5 0
North-East Coast—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates, ⅜in.	8 15 0	7 15 0
„ $\frac{5}{16}$in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ $\frac{3}{16}$in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6
Midlands, and Leeds and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 10 0
Plates, ⅜in. (basis)	8 17 6	7 15 0
„ $\frac{5}{16}$in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ $\frac{3}{16}$in.	9 12 6	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 5 0	6 15 0
Plates, ⅜in. (basis)	8 15 0	7 15 0
„ $\frac{5}{16}$in.	9 0 0	8 0 0
„ ¼in.	9 5 0	8 5 0
„ $\frac{3}{16}$in.	9 10 0	8 10 0
„ ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 0 0	6 10 0
Plates. ⅜in. (basis)	8 17 6	7 15 0
„ $\frac{5}{16}$in.	9 2 6	8 0 0
„ ¼in.	9 7 6	8 5 0
„ $\frac{3}{16}$in.	9 12 6	8 10 0
„ ⅛in.	9 7 6	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ⅜in. (basis)	9 0 0	9 2 6
„ $\frac{5}{16}$in.	9 5 0	9 7 6
„ ¼in.	9 10 0	9 12 6
„ $\frac{3}{16}$in.	9 15 0	9 17 6
„ ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r.	8 15 0	8 15 0
14-G to 20-G., d/d	10 0 0	9 0 0
21-G to 24-G., d/d	10 5 0	9 5 0
25-G to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/6 to 16/9.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/-
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/-
„ „ „ 1 p.c. carbon	£35 12 6	10/-
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½ per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, December 20th.

Copper—		
Cash	£33 3 9 to £33 5 0	
Three months	£33 6 3 to £33 7 6	
Electrolytic	£36 5 0 to £37 5 0	
Best Selected Ingots, d/d Birmingham	£37 5 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£228 0 0 to £228 2 6	
Three months	£228 2 6 to £228 5 0	
Lead:	£11 7 6 to £11 15 0	
Spelter:	£15 0 0 to £15 3 9	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	13/- to 13/6
„ Glasgow— Ell	13/- to 15/6
„ „ Splint	16/6
Ayrshire	
(f.o.b. Ports)—Steam	13/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	14/- to 14/6
Unscreened Navigation	12/6 to 13/-
Lothians—	
(f.o.b. Leith)—Hartley Prime	14/- to 14/6
Secondary Steam	13/3 to 13/6

ENGLAND.

Yorkshire, Manchester—		
B.S.Y. Hard Steams		17/6 to 20/6
Furnace Coke		13/- to 17/6
Northumberland, Newcastle—		
Blyth Best		14/- to 14/3
„ Second		12/9 to 13/-
„ Best Small		10/-
Unscreened		11/6 to 12/6
Durham—		
Best Gas		14/8
Foundry Coke		17/- to 18/6
Sheffield—	Inland.	
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	22/- to 24/-	—
South Yorkshire Seconds	17/6 to 19/6	—
Rough Slacks	6/- to 9/-	—
Nutty Slacks	7/- to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/-
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 27/-
Foundry Coke	20/- to 36/-
Furnace Coke	18/6 to 19/6
Patent Fuel	21/-
Swansea—	
Anthracite Coals:	
Best Large	35/- to 38/6
Machine-made Cobbles	35/- to 48/6
Nuts	37/6 to 48/6
Beans	25/- to 30/-
Peas	18/- to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/- to 20/-
Nuts	18/- to 25/-
Smalls	11/- to 13/-

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Tax on Foreign Labour.

The insertion of a clause in the Budget to impose a tax of 10 and 15 per cent. on the wages paid to foreigners, according to whether they occupy sedentary positions or are engaged in manual labour, complicates still further the problem of foreign workers who were imported in huge numbers during a period of industrial activity and are still employed on a much smaller scale in certain industries where French labour is not available. It is not certain yet whether the tax will be withdrawn before the final adoption of the Budget, in view of the opposition of employers and the difficulty of reconciling it with treaty obligations, but the suggestion that such a tax should be imposed shows clearly the change that has taken place in the industrial situation during the past four years. Prior to that period the demand for labour to meet a rapidly growing industrial development could only be satisfied by a large importation of men from Poland and other countries by means of a State organisation which supplied employers with men under conditions that placed them on exactly the same footing as French workers as regarded wages and social advantages. When the slump came men returned to their respective countries, and in three years about a million of them left, so that the problem of unemployment did not affect the country until last year. To-day the number of French workers receiving relief is steadily increasing, despite the departure of foreigners at the rate of from 700 to 800 a week. While the tax on foreign labour aims at bringing in fresh revenue, it is also intended to compel employers to extend the preference for French labour beyond the obligation already imposed upon them to employ only a stated percentage of foreign labour. Unfortunately for employers, this is not always possible, for in the north Belgians and Poles are engaged in coal mines, in mills and forges and other industries on work that the French are generally reluctant to undertake or of which they have not the same experience as foreigners, while from Marseilles there are strong protests against a tax which will seriously affect industries carried on almost entirely with Italian and other foreign labour. The tax will make a perilous addition to production costs. The difficulties raised by recent legislation regarding foreign labour reveal the anomalous position of some French industries which are dependent on foreign workers. In the event of a general industrial revival those industries may be placed in a serious situation unless French labour adapts itself to a class of work that is at present carried on mainly by foreigners.

Coal.

The demand for domestic coal has increased so largely during the present cold spell that the import quotas for January have been applied to the second half of the present month. At the same time the miners in the Nord and the Pas de Calais have made a further urgent appeal to the Government to take immediate steps for the relief of their unemployed. They want the Government to levy a tax on the coal brought to bank at the French collieries for the creation of a relief fund. The Minister of Public Works explained that he had already reduced the import quotas by 10 per cent. and had provided facilities for the transport of French coal in French ships to the coastal ports, but these remedies have obviously done little to alleviate the situation of the coal industry, for the reason principally that it does not produce steam coal of the quality required at the ports and also because, at a time when there is a heavy demand for other than industrial fuels, the canals are frozen and considerable quantities of coal are unable to be moved. In view of the slump in industrial coal the colliery companies are making great efforts to supply a domestic demand with composite fuels and semi-coke, which latter must be disposed of if the low temperature treatment of coal is to make any headway, and the companies are able to solve the difficult problem of making oil production commercially successful, but notwithstanding satisfactory technical results, and an increasing output of ammoniacal products, the situation of the industry is still affirmed by coalowners to be imperilled by foreign competition. Now that there is a heavier demand for domestic fuels more coal has to be imported.

The Surtax.

The Minister of Commerce, Monsieur Laurent Eynac, has confirmed in a statement made to the Parliamentary Customs Commission that the Government has prepared a decree suppressing the surtax on British goods, and he stated that an assurance had been given to Mr. Runciman which enabled the British Minister to suspend the application of the reprisal tax on French goods until the decree could be published and the law instituting the turnover tax repealed. Monsieur Eynac affirmed that this will be done towards the end of the month, and he held out the hope that a treaty of commerce between the two countries will be signed in the course of the ensuing few months. After the French Minister had described the disastrous boomerang effects of the surtax upon exporting industries the Commission left the Government with a free hand to carry out negotiations with Great Britain.

Air Organisation.

After suppressing the dual control of military and naval aviation and placing it directly under the Air Ministry and dividing the country up into zones with organisations for coast and frontier defence, the Air Minister proceeded with a reform of civil aviation by the fusion of the five air transport companies into one company. He has continued the reform of simplifying the organisation by authorising Chambers of Commerce to create and control air ports. Those in the districts of Paris, Lyons, Bordeaux and Marseilles will be made autonomous under the administration of the respective Chambers of Commerce. The State has therefore accepted the principle of private initiative in the laying out of landing grounds and promoting national air services with the approval of the State, and, judging from the number of plans that have been put forward from time to time, it appears likely that national air transport will enter upon a new phase, though occasional experimental working has shown that it has limitations.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

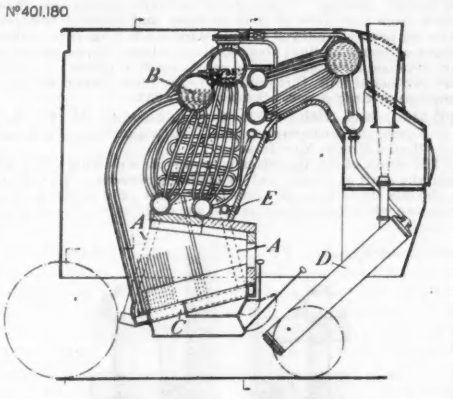
The date first given is the date of application ; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

401,180. April 10th, 1933.—Water-tube Boilers for Steam Wagons, Maschinenfabrik Esslingen, Esslingen-on-Neckar, Wurtemburg, Germany, and O. Gunther, 30, Mettinger Strasse, Esslingen-on-Neckar.

This remarkable boiler is put forward as being specially suitable for steam wagons and light locomotives on account of its compactness. Although the complicated system of water tubes and superheater is described in detail in the specification, the chief claim is for the arrangement of the down-comer tubes A A in the form of a triangle in order to transmit inertia forces, caused by the acceleration and braking of the vehicle, from the drum B to the foundation ring C, and thence to the frame of the vehicle. D is a feed-water heater and E the steam outlet.—*November 9th*, 1933.

Nº401,180

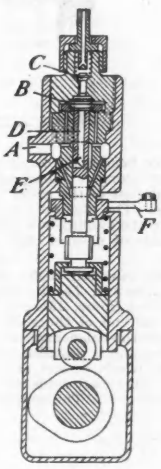


INTERNAL COMBUSTION ENGINES.

401,171. March 20th, 1933.—Fuel Pumps, H. L'Orange Feuerbacherweg 19, Stuttgart, Germany, and Simms Motor Units, Ltd., Percy-buildings, Gresse-street, Rathbone-place, London, W.1.

This fuel pump is of the fixed stroke type and its delivery is regulated by by-passing back to the suction. The suction inlet is shown at A and the suction valve, which is of the plate type, at B. The delivery valve is marked C. Governing is effected by the port D in the plunger registering, more or less, with a helical face E on the inlet port, according to the extent to which the plunger is turned by the crank F.—*November 9th*, 1933.

Nº401,171

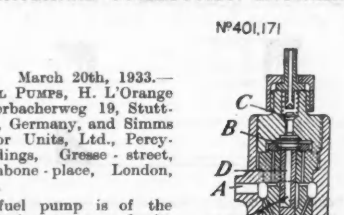


DYNAMOS AND MOTORS.

400,957. May 2nd, 1932.—Dynamo-electric Machines, the British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2, and Arthur Hemborough Maggs, of "The Briars," Wellsway, Keynsham, near Bristol.

This invention relates to rotating bodies subject to pulsating torque. An object of the invention is to balance the effects of the pulsations in the torque and so to reduce torsional vibrations in the body. The rotating shaft A transmits a load torque, and is also subject to pulsating torque. It may be the shaft of a dynamo-electric machine in which pulsations of torque are produced ; for example, in certain types of single-phase dynamo-electric machines pulsations of torque occur at twice the frequency of supply. The boss B is mounted on the shaft, and an annular mass C is supported concentrically thereon by spring members D giving torsional resilience with low damping. The invention is particularly applicable to lift drives. Pulsating torque results in humming noise in the cage, and it is found that this may be eliminated by the application of the invention. A single device according to the invention will only balance the effects of pulsating torque of one frequency. If a rotating body is subject to pulsating torques of several definite frequencies, each may be balanced by a separate device according to the invention.—*November 2nd*, 1933.

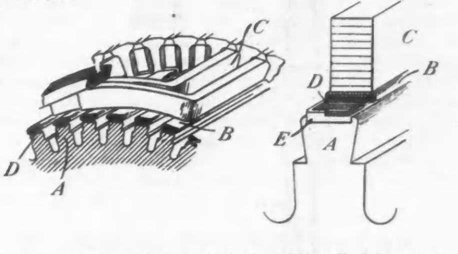
Nº400,957



401,009. May 9th, 1932.—Windings of Dynamo-electric Machines, International General Electric Company Incorporated, of 120, Broadway, New York, U.S.A.

A scheme is described in this specification for allowing the end windings of electrical machines freely to expand, the invention being particularly applicable to long machines. The rotor end is provided with teeth A. Bars B are arranged over the teeth on which the end windings C lie. Each bar covers a roller bed filled with steel rollers D of small diameter over the peripheral surfaces of the teeth. The roller path on the tops of the teeth is formed by way of example as a box-shaped holder E, so that the rollers are guided and secured against lateral deviations from their path. It is fastened on the tops of the teeth in any suitable manner.—*November 9th*, 1933.

Nº401,009

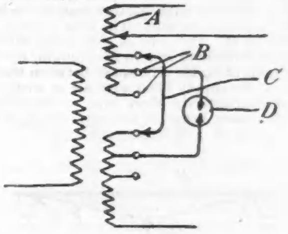


TRANSFORMERS AND CONVERTERS.

400,962. May 3rd, 1932.—On-load Tap-changing Arrangements for Electric Transformers, the British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2, and Charles Gilbert Mayo, of 17, Alexandra-road, Rugby.

The object of this invention is to provide an on-load transformer tap-changing equipment arrangement whereby the switching connections are greatly simplified while still obtaining the advantages of the complicated switching connections heretofore employed. The diagram shows a transformer having a secondary winding A divided into two sections, adjacent ends of which are provided with taps B arranged for connection by a movable bridging member C. In order to prevent the secondary circuit from being interrupted when the bridging member is moved from one tap to an adjacent tap, a gas discharge tube D is connected, as shown, the breakdown voltage of which is such that no current normally passes it. When, during tap-changing operations, the bridging contact is initially separated from a tap, the voltage across the tube D rises to a value sufficient to cause current to flow through the tube, and thus undue sparking at the taps is prevented. When the tap-changing operation is completed, the tube returns to its normal non-conductive state.—*November 3rd*, 1933.

Nº400,962



TRANSMISSION OF POWER.

400,235. March 17th, 1932.—Insulated Electrical Cables, Johnson and Phillips, Ltd., of Charlton Park, S.E.7; Albert Periam Pyne, of 7, Kidbrook Park-road, Blackheath, London, S.E.3 : and Tom Bond Parker, of 30, Repton-road, Orpington, Kent.

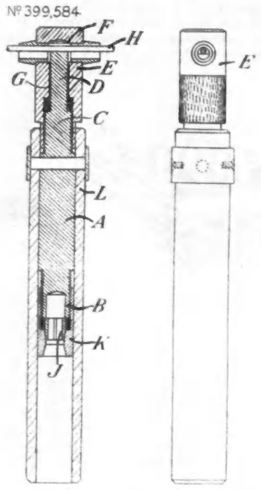
The di-electric or covering applied to electrical cables usually contain ingredients of an inflammable nature. This applies particularly to the insulation of paper-insulated cables, which consists of lappings of thin paper tapes saturated with impregnating compound, such as mineral oil, having a considerable resin content. This inflammability is frequently very inconvenient, as, for example, when a fault is being burnt out in a cable laid in a duct. On such occasions the di-electric or cover of the cable frequently burns along the duct for many yards in each direction from the fault. It is the primary object of this invention to provide improved means whereby the inflammable material of a cable di-electric or cover will be prevented from burning and the invention consists broadly in the arrangement that the covering includes a layer of fibrous material impregnated with a non-inflammable chlorinated naphthalene, which, on the application of heat, generates combustion-resisting gas, the layer not being otherwise treated with flame-resisting compound. In the case of the paper-insulated cables the paper may be impregnated with poly-chlorinated naphthalene in place of the usual compound, either before or after application to the cable. It is found that insulation so impregnated cannot be ignited, or if the application of heat be intense enough to char or burn the papers, such burning or charring will be only local, and will cease immediately the source of heat is removed. A further advantage of such insulation is that, should a cable break down, the effects will be felt to a less extent on surrounding cables, since the gases generated from the impregnating compound by the arc will tend to damp it out quickly.—*October* 17th, 1933.

WELDING.

399,584. April 28th, 1932.—Electrode Holder for Use in Electric Arc Welding, Bernard Wasley Rowe, of 290, Derbyshire-lane West, Stretford, Manchester, and Associated Electrical Industries, Ltd., of Crown House, Aldwych, in the City of Westminster.

The welding electrode holder described in this specification comprises a body portion A of copper or steel having reduced portions at each end. The reduced portion B at the lower end is screw-threaded and the reduced portion C at the upper end is also screw-threaded, the upper part of the latter portion being reduced in diameter to constitute a plunger D. The lower screwed portion accommodates means whereby the current-carrying cable for the tool is attached, and the portions C and D serve for the accommodation of the device for gripping the electrode. The electrode-gripping device comprises a metal bar E, which is drilled with a transverse hole F near its upper end. An axial hole G extending from the lower end of the bar and slightly greater in diameter than the diameter of the plunger D on the holder A communicates at its upper end with the transverse hole F. At its lower end the axial hole G is increased in diameter and internally screw-threaded to engage the threaded portion C of the holder, so that the bar E may be screwed on to the portion C of the body and make good electrical contact therewith. By screwing the portion E on to the portion C the plunger D in the axial hole G is forced transversely across the transverse hole to retain the electrode H securely in position. The body portion A and the cable-gripping device J, K of the holder are covered with an insulating sleeve L, so that the device can be safely held in the hand of the operator.—*October 12th*, 1933.

Nº 399,584

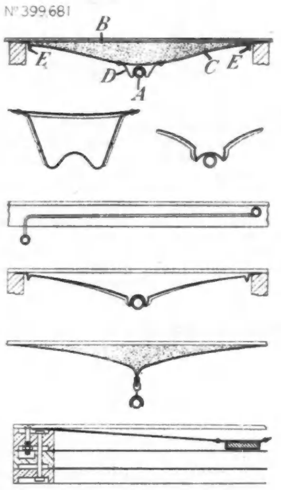


LIGHTING AND HEATING.

399,681. December 19th, 1932.—HEATING OR COOLING PANELS W. Deriaz, 16, Rue de Villereuse, Geneva (Switzerland).

The object of this invention is to enable a network of heating or cooling pipes spaced at considerable intervals to transmit to the radiation surface, such as wall panels, or the floor, a uniform intensity of heat or cold. The heating pipe is shown at A and the floor at B. The pipe is connected with a "distributor" C, which is made of iron or aluminium, by clips D. It has expansion folds at E, E. The space between the distributor and the floor may be simply filled with air or with "a material with a weaker conductivity than iron or aluminium." The thickness of the space between the distributor and the floor diminishes from the point nearest the pipe to the extremities of the distributor, so that the heat liberated near the pipe will have greater difficulty in reaching the floor than that liberated near the extremities of the distributor. The cross section of this latter, as also the thickness of the space, are so chosen that a determined, practically constant quantity of heat is transmitted to the floor per surface unit, and that the quantity of heat continuing its course in the distributor is sufficient in order that, at the extremity of this latter, the heat transmitted directly to the floor is equal to that quantity. In practice, the distributor has a constant thickness and is made in stamped aluminium or iron sheeting.—*October 12th*, 1933.

Nº 399,681

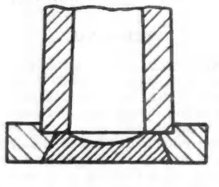


METALLURGY.

400,010. September 16th, 1932. INGOT MOULDS, J. Puppe, 19, Beethovenstrasse, Düsseldorf, Germany.

When an ingot is rolled down into a bar the exterior is naturally extended more rapidly than the centre, with the result that the bar or billet has hollow ends that must be cropped off. The inventor proposes to overcome this waste by making the ingots with rounded ends. The arrangement of the mould is shown in the illustration, from which it will be seen there is a false bottom that may be changed to give a contour of the end of the ingot appropriate to the subsequent rolling operations.—*October 9th*, 1933.

Nº 400,010

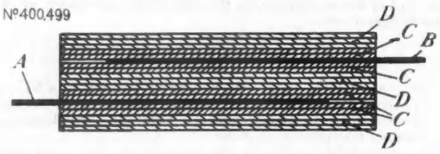


MISCELLANEOUS.

400,499. March 14th, 1933.—DI-ELECTRIC OF CONDENSERS, *William Warren Triggs, of Marks and Clerk, of 57 and 58, Lincoln's Inn-fields, London, W.C.2.*

The impregnation applied to the dielectric of electric condensers in accordance with this invention is said to have a very high degree of resistance to the initiation of glow discharges. Impregnated cellulose paper is placed nearest to the metal layers and at a greater distance from the metal layers impregnated rag paper is arranged. The reason for the improved performance lies in the greater chemical inactivity of the cellulose paper against the action of electrical glow and radiation processes, and also in the smaller di-electric losses of the rag paper, more particularly at the raised temperatures due to the di-electric heating. Examples of cellulose papers are those made from the fibres of soda cellulose and sulphite cellulose. The rag papers employed include those made from rags or from fibres of hemp or flax, that is, those whose fibrous materials are obtained from non-lignified constituents of plants. A and B are two metal foils, C is impregnated cellulose paper, and D is impregnated rag paper.—*October 26th*, 1933.

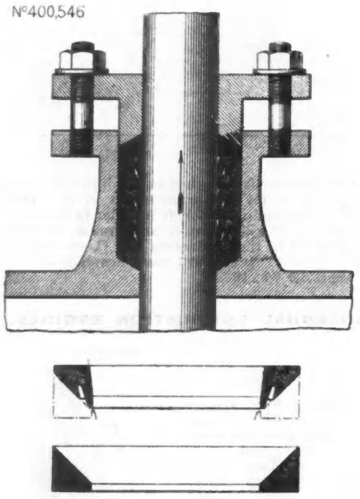
Nº 400,499



400,546. May 18th, 1933.—STUFFING-BOXES, E. R. Roy, Corner of Bridgewater and Wharton-avenue (Finderne). Bound Brook, New Jersey.

The object of this invention is to provide a packing which will grip the shaft or plunger only when leakage occurs. To this end a flexible lip is pressed against the shaft or plunger by fluid pressure when leakage occurs and the shaft moves in one direction, the flexible lip being released on the return stroke of the shaft or plunger. The packing therefore does not depend on the tightness of the gland to compress the packing to prevent leakage. The illustrations show the assembly of the packing rings in the stuffing-box and details of two of the rings, which are made of plies of cloth cemented together.—*October 26th*, 1933.

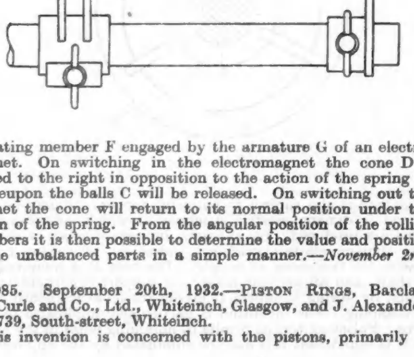
Nº 400,546



400,880. June 9th, 1933.—MACHINES FOR BALANCING ROTATING ELEMENTS, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

On the end of the shaft A of the body to be balanced is mounted the balancing head B, which is constructed as a hollow cylinder, and is provided with a track for the movable balance weights which consist of balls C. The cone D of a friction coupling normally holds the balls C in the track under the action of a spring E. The coupling cone is provided with a central operating member F engaged by the armature G of an electromagnet. On switching in the electromagnet the cone D is moved to the right in opposition to the action of the spring E, whereupon the balls C will be released. On switching out the magnet the cone will return to its normal position under the action of the spring. From the angular position of the rolling members it is then possible to determine the value and position of the unbalanced parts in a simple manner.—*November 2nd*, 1933.

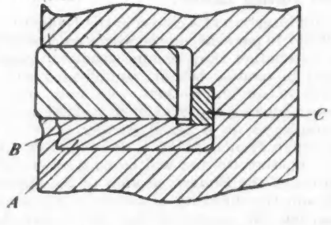
Nº 400,880



401,085. September 20th, 1932.—PISTON RINGS, Barclay, Curle and Co., Ltd., Whiteinch, Glasgow, and J. Alexander, 739, South-street, Whiteinch.

This invention is concerned with the pistons, primarily of oil engines, made of steel, but equipped with rings of cast iron. It is desired that the rings should have a rubbing surface in their grooves, also of cast iron. This surface is provided by the ring A, which is held in place by knurling at B and welding at C. In this way the welding is kept away from the cylinder walls, and will not produce scoring if it should break away.—*November 9th*, 1933.

Nº 401,085



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

THURSDAY, DECEMBER 28TH.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Christmas Juvenile Lectures. "Through Space and Time: I., Earth and Moon," Sir James Jeans. 3 p.m.

SATURDAY, DECEMBER 30TH.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle Street, W.1. Christmas Juvenile Lectures. "Through Space and Time: II., Moon and Planets," Sir James Jeans. 3 p.m.

1934.

THURSDAY, JANUARY 4TH.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "Nickel and Nickel Alloys," Mr. W. R. Barclay. 7 p.m.

FRIDAY, JANUARY 5TH.

INST. OF SANITARY ENGINEERS.—Caxton Hall, S.W.1. Presidential address, Mr. Godfrey M. C. Taylor. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Reproduction of Engineering Drawings," Mr. G. V. Rickards. 7.30 p.m.

SATURDAY, JANUARY 6TH.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. Club dance. 7.30 to 11 p.m.

MONDAY, JANUARY 8TH.

ELECTRODEPOSITORS' TECHNICAL SOC.: MIDLAND CENTRE. James Watt Memorial Inst., Birmingham, 3. "Electrodeposition for Wear Resistance," Dr. J. Kronsbein. 7.30 p.m.

STEPHENSON LOCOMOTIVE SOC.—King's Cross Station, N.1. "The Railways of Switzerland over Mountain and Plain," Mr. R. A. H. Waight. 6.30 p.m.

TUESDAY, JANUARY 9TH.

INST. OF METALS: N.E. COAST LOCAL SECTION.—Armstrong College, Newcastle-upon-Tyne. "Physical Properties of Deposited Weld Metal in the Arc-welding and Atomic Hydrogen Processes," Messrs. C. R. Deglon and L. Miller. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. Annual general meeting. 7.30 p.m.

TUESDAY TO THURSDAY, JANUARY 9TH TO 11TH.

PHYSICAL SOCIETY.—At Imperial College of Science and Technology, S. Kensington, S.W.7. Exhibition. 3 p.m. Discourse, "Evolution of the Galvanometer," Mr. R. S. Whipple. 8 p.m. Wednesday, 4 p.m., discourse, "Instrumental Side of Calorimetry," Mr. J. Guild. 8 p.m. Thursday, 3 p.m., discourse, "History and Development of the Thermionic Valve," Sir J. Ambrose Fleming, F.R.S. 8 p.m.

WEDNESDAY, JANUARY 10TH.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—At Offices of Holophane, Ltd., Elverton-street, Westminster, S.W.1. "Some Modern Uses of Glass," Mr. G. Novell. 7.30 p.m.

THURSDAY, JANUARY 11TH.

INST. OF METALS: LONDON LOCAL SECTION.—At Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "Beryllium and its Alloys," Mr. H. A. Sloman. 7.30 p.m.

FRIDAY, JANUARY 12TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Mr. B. D. Parritt will introduce discussion on "Rubber and its Engineering Uses." 7 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—The University, Sheffield. "Protection from Corrosion of Aluminium and its Alloys," Mr. N. D. Pullen. 7.30 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Why the L. and N.W. Railway was the Premier Line," Mr. J. D. Godfrey. 7.30 p.m.

MONDAY, JANUARY 15TH.

INST. OF METALS: SCOTTISH LOCAL SECTION.—39, Elmbank-crescent, Glasgow. "Factors in the Solidification of Molten Metals," Dr. Sydney W. Smith. 7.30 p.m.

TUESDAY, JANUARY 16TH.

INSTITUTIONS OF MECHANICAL AND ELECTRICAL ENGINEERS: GRADUATE AND STUDENT SECTIONS AND LONDON STUDENTS OF CIVIL ENGINEERING.—Joint Dance at Victoria Halls. 7.30 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "Electric Welding," Mr. C. A. Hadley. 7 p.m.

WEDNESDAY, JANUARY 17TH.

INST. OF AUTOMOBILE ENGINEERS.—Metropole Hotel, King-street, Leeds. "Repairs," Mr. J. Dent. 7.15 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Modern Developments in Street Lighting," Mr. J. M. Waldram. 8 p.m.

THURSDAY, JANUARY 18TH.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "The London Building Act of 1930 and its Effect on Structural Design," Mr. W. C. Cocking. 7 p.m.

LIVERPOOL ENGINEERING SOC.—Adelphi Hotel, Liverpool. Annual dinner. 7 p.m. for 7.30 p.m.

FRIDAY, JANUARY 19TH.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

A Seven-Day Journal

The French Railway Disaster.

There is no parallel in French railway history to the lamentable accident that occurred on Saturday night last near Lagny, on the Est line, when the express from Paris to Nancy was telescoped by a train from Paris to Strasburg. Owing to a fog which was dense around Paris and made visibility very bad along the line the trains started at their regular intervals an hour and a half late. The express was composed of nine wooden coaches, and the Strasburg *rapide* was drawn by a " Mountain " type locomotive with steel coaches, the former train carrying a particularly heavy Christmastide load of passengers. Between Lagny and Vaires, about 16 miles from Paris, the express was stopped by signals for quite a long time, and the Strasburg train coming up behind at a speed of about 60 miles an hour, which was below the maximum speed permissible on that section of the line, practically ran through four coaches, smashing them up completely and destroying a fifth coach. At the time of writing the exact number of casualties is not known, but it is certain that over 200 passengers were killed and about 400 injured. The driver of the Strasburg train has been working on the line for more than twenty years. He affirms that the signal showed the section of the line to be at clear, and that he only saw the rear lights of the Nancy train when about 50 yards away. The signals are automatic throughout, and the driver's statement that the signal was at clear when he passed it appeared to be strengthened by the declaration of two witnesses that the detonator beyond the signal exploded under the two last coaches. A statement to the effect that the driver of a train on the up line stopped within 150 yards of the wreckage because he found that the signal went to danger while he was passing it, is repeated here merely as indicating suspicion that the automatic signals were not working normally. The driver and fireman of the Strasburg train were arrested, but later were released. This deplorable disaster is remarkable for the complete destruction of the wooden coaches, while the steel coaches of the Strasburg train appear to have suffered little damage. No one was seriously injured in that train. The Minister of Public Works has already declared that he will endeavour to obtain credits for the immediate construction of more steel coaches. The first stage of the technical inquiry, which has already been opened, is to determine the reliability of the automatic signalling system, particularly with regard to its instantaneous action. Simultaneously with the "raising" of the signal, a detonator is placed on the rail. If, therefore, the system were working properly, it is incredible that the driver of the Strasburg train should have failed to hear the particularly strident alarm whistle which is sounded on the locomotive by a signal at danger, or the detonator when passing a distant signal at danger. Pending the technical inquiry, public faith in the automatic signalling system in France has been shaken, and confidence will only be restored when it is definitely shown that the system is not at fault, or that adequate precautions have been taken to avoid disasters in the future. Our fullest sympathy is extended to the Compagnie de l'Est and to the friends of those who lost their lives in this disaster.

New Industrial Developments at Derby.

Considerable satisfaction is felt in the Derby district at the announcement that important extensions are to be made early next year to the works of Ley's Malleable Castings Company, Ltd., and Qualcast, Ltd., which firms have recently been devoting attention to the production of motor car parts. The new Ley's works, which will be completed in June, are to be built on three acres of land purchased from the London, Midland and Scottish Railway Company, and will, it is expected, give employment to about 400 men. The Qualcast works are to be extended by a new shop, which will give a 25 per cent. increased output for the firm. Extensions are also to be made to the works of Derby Cables, Ltd. A new air service which is being planned by the London, Scottish and Provincial Airways, Ltd., for a through service from Croydon to Renfrew, with halts at Derby and Manchester, is, it is understood, being supported by Rolls-Royce, Ltd., of Derby. The machines which will probably be used will be the Airspeed Courier with Armstrong-Siddeley 240 B.H.P. air-cooled engine having a cruising-speed of 140 m.p.h. The provisional schedule provides for four services per day in either direction, beginning in March with, at first, Manchester as a terminus.

The Late Sir Frank Baines.

Although Sir Frank Baines, whose death, at the age of fifty-six years, occurred on Christmas Eve, was an architect by profession, so much of his work was of a truly engineering character that it is fitting that his death should be recorded in these pages. He was a man of outstanding personality and great strength of purpose. For some years during his tenure of the office of Director of Works to the Office of Works he was responsible for the maintenance and restoration of many famous ancient buildings, of which Westminster Hall and the Banquetting Hall at Hampton Court are perhaps the most celebrated. In both cases the ancient woodwork had been riddled by the death-watch beetle until it was in a precarious condition. In Westminster Hall he effected restoration by introducing skilfully concealed steel work amongst the ancient timbers of the hammer beam roof, his effort being to preserve as much of the old wood as possible. His procedure has been, and still is, severely criticised by architects, some of whom believe that the beetle has not been got rid of by the poison used for that purpose, whilst others fear that stresses on the ancient walls have been set up by the new steelwork. In 1927 he retired from the Office of Works to take up private practice, and he was the architect to the two buildings at Millbank which have entirely altered its appearance—the house of Imperial Chemical Industries, Ltd., and Thames House. Sir Frank was an effective speaker and lecturer, and in November, 1922, delivered a lecture to the Institution of Mechanical Engineers on the subject of Westminster Hall. He was a firm believer in the restoration of ancient buildings to their old appearance, as far as possible, and a stout opponent of what he called, derisively, the " ivy tod " ruins. He was one of those men who give one the feeling that they would succeed in whatever they undertook.

Rural Water Supplies.

On Thursday, December 21st, Sir Hilton Young, the Minister of Health, received a deputation from the Parliamentary Agricultural Committee on the subject of rural water supplies. The deputation pointed out that the Committee was anxious to learn on what conditions and through what channels the proposed Government grant of £1,000,000 would be made. It regarded the importance of the complementary problem of sewage disposal, and emphasised the need of a comprehensive plan of water supplies as a whole. In his reply, the Minister stated that he would consider the various points raised by the deputation and would be glad to keep in touch with the Agricultural Committee. The scheme was intended to assist rural supplies, and its object would be the development of local resources. At the same time, whenever the technical circumstances demanded a scheme on a wider basis, full use would be made of the Regional Committee machinery. Speaking in the House of Commons on Thursday evening, December 22nd, in reply to a question put by Mr. Alan Chorlton, asking whether the organisation of the Ordnance Survey could be used for the purpose of a hydrogeological computation of our water resources, the Minister stated that he was informed that the Ordnance Survey was not equipped for work of that kind, but that the Government derived most important and useful information from the Geological Board.

A Temporary Grid Failure.

A temporary failure, caused by flashing over of the insulators on the national grid in the Southern Counties, occurred during the night of Tuesday, December, 19th, and on the following morning, when serious delays were caused to trains running between London and Brighton and other Sussex towns. In many cases a delay of over three-quarters of an hour took place, owing to lack of lights for signalling and of power for traction purposes. The failure was directly caused by the spell of fog and frost, which was of unexpected severity, and a repetition of similar troubles will in future be guarded against by increasing the number of insulators from eight or nine to ten or eleven as may be required. Similar trouble has been experienced in Scotland and the North, but was quite unexpected in the affected area. Owing to the unexampled call for current the three stations—Brighton, Three Bridges, and Croydon—were seriously overloaded in turn, and it is some satisfaction to know that the safety and protective gear worked in every case without a hitch.

Co-operative Profit Sharing.

Trading results for 1932 in co-operative prcductive societies were published recently by the Co-operative Productive Federation, the details serving to stress the difficult conditions with which that year had to contend. The forty-three federated societies had an aggregate membership of 15,854, with a share and loan capital of nearly 1½ million sterling. There were 7497 employees at the end of the year, the wages bill totalling just over three-quarters of a million pounds. The turnover came to 2½ millions, and gave a net surplus of £106,856; both these latter totals show a slight decrease over those for 1931. From the surplus, capital received £6277, about £29,948, and customers £54,150, while grants to educational and charitable purposes amounted to £3891. There are five societies in the group devoted to metal-working and miscellaneous industries, four of which are connected with the engineering and allied trades. The largest of the four is the Walsall Locks and Cart Gear, Ltd. At the end of 1932 it had 326 members, a share and loan capital of £22,839, and 307 employees, a turnover of £61,476, giving a net surplus of £852, of which £21, or 1½ per cent., was distributed to capital, and £483, or 4d. in the £ on wages, to labour. Of the other three engineering societies, Chesham Builders, Ltd., was the only one declaring any bonus. It had 48 members, and with a capital of £839 and 26 employees, it did business to the value of £9777, and had a surplus of £239. Sixpence in the £ on wages was given to labour, the distribution totalling £73. Alcester Needlemakers, Ltd., had 139 members and a capital of £3306. Its turnover amounted to £13,471, although only seven workpeople were employed at the end of the year. There was a net surplus of £21. The last of the four societies in this group is the Leicester Carriage Builders, Ltd. With a membership of 182 and a share and loan capital of £6281, its business amounted to £12,085, resulting in a net loss of £413. It had 27 workpeople on its pay roll. The figures here given complete the results of profit-sharing for the year 1932, the details for ordinary competitive concerns, summarised from the Ministry of Labour's return, having been given in a Journal note on June 23rd last.

Shipbuilding Outlook on the Clyde.

The river Clyde is at the moment the busiest shipbuilding centre in the world, for in the last quarter of the year shipbuilding orders aggregating more than one million pounds were placed with shipbuilding yards and engine works on the river. Added to these new orders, there are good prospects of an early resumption of work on the new Cunarder, while important Admiralty contracts are expected. New British and Colonial orders will, it is anticipated, be placed early next year, and it is understood that tenders have been recently submitted by Clyde firms for the reconstruction of the Brazilian and the Estonian Navies. Although the output of the Clydeside shipyards during 1933 was the lowest on record, only thirty-one ships of about 56,000 gross tons total being launched, that total was greater than the total output of English yards. The industrial future must still be viewed with restrained optimism, and it is still worthy of record that, whereas at the beginning of 1933 only roughly 5 per cent. of the shipyard berths were occupied, the number now in use, which, it is hoped, will shortly be considerably increased, is about 25 per cent. of the available shipbuilding berths on the river.

The Science Museum.

An extension to the Children's Gallery of the Science Museum, South Kensington, which was officially opened on Friday, December 22nd, further extends the idea worked out by Sir Henry Lyons, and begun two years ago. The gallery as a whole has now been rearranged and an endeavour has been made to bring the old exhibits and the new into a more logical sequence. The first exhibit in the gallery is the practical demonstration of a rainbow, and as far as possible the physical exhibits have been arranged near the entrance, the visitor passing from them to practical applications. They include the existing large interiors representing the work of the smith, the flint worker, and the potter, along with the working models illustrating the production of power by the energy of animals, by wind, water, and steam. These are followed by small interiors depicting the development of lighting through the ages, and a series of new scale models illustrating the benefits which have been conferred upon the community by the advent of gas and electric power. Some additions have also been made to the exhibits of lifting appliances, all of which can be worked by the visitors themselves. The progress in methods of communication is well illustrated by a series of exhibits, the first of which shows a primitive beacon and the last a modern telephone exchange. A number of exhibits from the exhibition of photo-electric cells held during last summer have now been transferred to the Children's Gallery, and arrangements have been made to exhibit several short films. The educational value of the old and new exhibits will doubtless be greatly appreciated during the school holidays.

New Shipbuilding Orders.

During the past week several important shipbuilding orders have been placed. It is announced by the Peninsular and Oriental Steam Navigation Company, Ltd., that an order has been placed with Vickers-Armstrong, Ltd., of Barrow-in-Furness, for the construction of a fast mail and passenger liner of over 20,000 gross tons for the P. and O. fleet. The new ship, which will give employment to between 3000 and 3500 workers for a year and a-half, will, we understand, be propelled by twin-screw geared turbine machinery taking steam from water-tube boilers. John Brown and Co., Ltd., of Clydebank, are to build a twin-screw motor cargo liner for the Australian and New Zealand service of the Commonwealth and Dominion Line. It will have a tonnage of about 8800. On the other side of the Clyde, at Renfrew, Lobnitz and Co., Ltd., are to build a large gold dredger for working in the alluvial valleys of the river Pek on the Yugoslav-Roumanian border. It will be designed to dig and treat 6000 tons of alluvial gravel per day and will float in a pond or paddock, rejecting the treated material astern and excavating forward, thus creating the pond in which it works.

Recent American Express Locomotives.

By E. C. POULTNEY.

No. II.

(Concluded from page 617, December 22nd.)

4–8–2 and 4–8–4 Type Locomotives.

In considering now engines of the eight-coupled type, the first example given in Table II. (repeated from last week) represents the latest "Mountain" type, introduced by the Pennsylvania in 1930. Actually the design is a development of an experimental 4–8–2 built for test purposes at Altoona in 1923. It may be interesting to note briefly the evolution of this type of engine on the Pennsylvania. Prior to the building of the 4–8–2 type, all important trains were handled by the "K.4.s. Pacifics" or the "E.6.s. Atlantics," but heavier trains and the difficult road between Altoona and Pittsburg, between which points the line crosses the Alleghenies, demanded engines of much greater power. Accordingly a large 4–8–2 was designed in 1923. This engine, with 37in. by 30in. cylinders, 72in. wheels, and 250 lb. boiler pressure, represented a great advance in power over the existing engines mentioned, as it had a rated tractive effort of 64,550 lb. The boiler had a type E superheater and a total heating surface of 6704 square feet with a grate area of 70 square feet, and weighed, engine only, 384,300 lb. A number of trials were made with this engine, both on the plant and on the road, and experience showed that at high powers the steam volume given by the boiler was deficient. Alterations in the boiler diameter were made, and with good results, and a revised design of generally the same dimensions appeared in 1926. This engine, one of which is illustrated in Fig. 9, is, like the original, classified M.1. The boiler is remarkable for the very large fire-box and combustion chamber, the latter being 8ft. 2in. long, and in consequence the tube length is only 19ft., which is short for an eight-coupled engine. This arrangement was used also for the trial engine. The cylinders, wheels, and steam pressure are as before, but instead of being hand fired a stoker is fitted. During 1926 and 1927 the Pennsylvania placed 200 of these locomotives in fast passenger and freight traffic. They were built by Baldwin and the Lima Locomotive Works. Their success led to the design being developed further, and in 1930 those of the class M.1.a., as next shown—Fig. 10—were built. The dimensions given in Table II. relate to the M.1.a. class, but are applicable to the previous M.1., except for the weights and data relative to the tenders which are much longer for the newer locomotives. In construction, the M.1.a. class differ in having a one-piece cylinder casting in steel, with a saddle, which, as in the case of the "K.5 Pacifics," is long enough to constitute practically the bottom of the smoke-box. A further change of importance is the inclusion of a feed-water heater; the type used is the Worthington S pattern, of very large capacity, capable of supplying 62,108 lb. of water per hour. The tender is of exceptional size, with a 22,000-gallon tank and space for 63,000 lb. of coal. A scoop is provided.

Table II.—*Examples of Recent Passenger Locomotives of the 4–8–2 and 4–8–4 Types.—General Dimensions and Ratios.*

Railway	Penn. R.	C.R.I. & P.	B. & O.	D.L. & W.	C. & N.W.	G.N.	D.& R.G.W.	C.M. & St. P.	A.T. & S.F.
Type	4–8–2	4–8–2	4–8–2	4–8–4	4–8–4	4–8–4	4–8–4	4–8–4	4–8–4
Date	1930	1929	1930	1927	1929	1930	1929	1930	1929
Cylinders, diameter and stroke, inches	27 × 30	28 × 28	27½ × 30	27 × 32	27 × 32	29 × 29	27 × 30	28 × 30	30 × 30
Driving wheels, diameter, inches	72	74	74	77	76	80	70	74	73
Boiler working pressure	250	200	250	250	250	225	240	230	210
Rated tractive force	64,550	50,400	65,000	64,500	65,200	58,300	63,700	60,000	66,000
Heating surfaces, square feet:									
Tubes and flues	4,303	4,069	5,015	4,700	4,656	4,402	4,471	4,860	5,132
Fire-box	395	368	491	493	558	379	446	540	540
Total evaporative	4,698	4,437	5,506	5,193	5,214	4,781	4,917	5,400	5,672
Superheater	1,634	1,327	2,451	1,324	2,357	2,265	2,229	2,403	2,426
Combined	6,332	5,764	7,957	6,517	7,571	7,046	7,146	7,803	8,098
Grate area	69·86	63·0	92·3	88·2	100·0	97·7	88	103·0	108·0
Weights, lb.:									
On drivers	271,000	255,500	260,000	269,000	288,000	247,300	252,000	258,814	272,880
On leading truck	59,000	63,000	62,000	62,500	87,000	78,000	64,000	79,330	65,410
On trailing truck	60.000	59,500	63,000	89,500	123,000	95,600	92,500	112,694	93,950
Engine total	390,000	378,000	385,000	421,000	498,000	420,900	408,500	450,838	432,240
Tender	378,360	194,000	273,000	216,000	320,000	326,900	269,500	289,162	292,260
Locomotive	758,360	572,000	658,000	637,000	818,000	747,800	678,000	740,000	724,500
Ratios:									
Weight on drivers per cent. of total	69·4	67·7	67·5	64·1	57·7	58·7	61·7	57·3	63·1
Engine weight ÷ comb. heat. surface	61·5	65·7	47·2	64·5	65·9	59·8	57·2	57·4	53·3
Adhesive factor	4·2	5·07	4·0	4·17	4·42	4·24	3·96	4·3	4·13
R.T.F. × dia. of drivers ÷ comb. heat. surface	733	647	604	762	655	663	621	567	597
Superheat surface per cent. of combined	25·8	23	30·8	20·3	31·1	32·2	31·2	30·8	30·1
Combined heat. surface ÷ grate area	79·3	91·5	86·0	73·8	75·7	72·1	81·6	76·4	74·7
Superheater, type	E	A	E	E	E	E	E	E	E

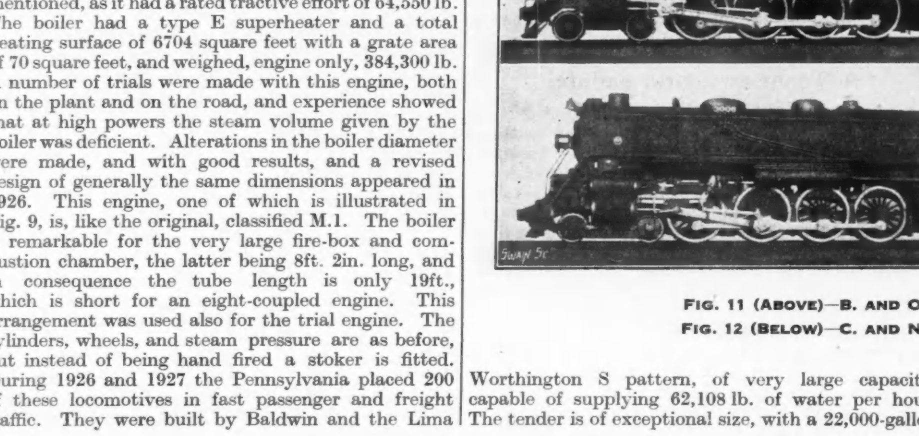


Fig. 9 (Above)—P.R. Class M.1 4-8-2 Type Locomotive, 1926

Fig. 10 (Below)—P.R. Class M.1.A. 4-8-2 Type Locomotive, 1930

As was the case with the two previous designs, one of these engines has been tested on the Altoona plant and shown a very high capacity. When working all out the indicated horse-power developed was 4662 and at the draw-bar 4034. This power output was attained at 240 r.p.m. and 65 per cent. cut-off. The boiler showed an equivalent evaporation of 113,368 lb. per hour, or an actual of 92,084 lb. The dry coal fired per hour was 21,271 lb. and the steam pressure maintained averaged 241 lb. per square inch delivered at a total temperature of 733 deg. Fah.

The Baltimore and Ohio (B. and O.) engine—Fig. 11—has been built by Baldwin to the requirements of Mr. Emerson. The design is experimental, being specially worked out to comply with severe weight and clearance limitations, whilst, at the same time, developing high power for operation in heavy passenger services. It will be noted that the engine is very light in comparison with the heating surface provided. The cylinders are 27½in. by 30in., and the piston valves have a diameter of 12in. and a full gear travel of 7in. when the cut-off is 87 per cent. As will be seen, Walschaerts gear is used. The superheater is of the E type, and two Nicholson syphons are fitted in the fire-box. Other equipment includes cast steel cylinders, Sellars exhaust steam injector, power reverse gear, and a mechanical stoker of the Lower pattern. The length between the tube plates is 21ft., and there are fifty-nine 2¼in. tubes, and 224 3½in. flues. The superheating surface is 2451 square feet, or 30·8 per cent. of the combined total of 7957 square feet. All the motion parts have been carefully proportioned to save weight, and the same remark applies to the frame construction, which is of the normal type, but the cross stretchers are welded to the side members, thus eliminating to a large extent bolts in the building of the frame structure. The tender is of the Vanderbilt design, and runs on two four-wheeled trucks. It carries 18,000 gallons of water and 20 tons of coal, and has a loaded weight of 273,000 lb., and is light for the carrying capacity. A further engine of the same general design is also in traffic, but having an Emerson water-tube fire-box and type A superheater.

The dimensions of a large locomotive having the 4–8–4 wheel classification is given by the next example in the Table. Five were built in 1927 by the American Locomotive Company for the Delaware, Lackawanna and Western (D.L. and W.) for fast passenger service, principally between Hoboken, N.J., and Scranton, Pa. These engines are remarkable for the large size of their coupled wheels, and the high tractive effort of 64,500 lb. The 77in. drivers were, when the engines were built, the largest found in an eight-coupled design. The line between Hoboken and Scranton crosses the Pocono Mountains over steep gradients, both east and west-bound, but on the more favourable sections of the run some high speeds are required; hence the large diameter driving wheels. These engines are stoker fired, and provision is made for the application of a booster to the rear axle of the trailing engine truck if required.

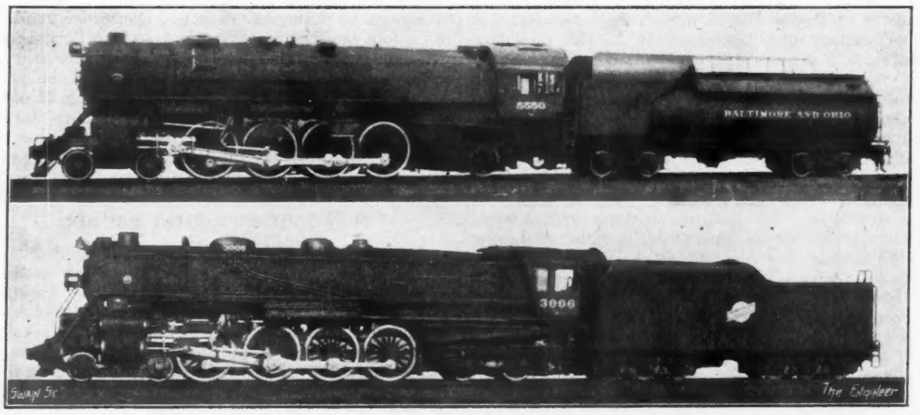


Fig. 11 (Above)—B. and O. 4-8-2 Type Locomotive

Fig. 12 (Below)—C. and N.W. 4-8-4 Type Locomotive

The Baldwin Locomotive Works built the Chicago and North-Western (C. and N.W.) engines represented by Fig. 12, which are amongst the largest passenger engines so far built. The tractive effort with the normal boiler pressure of 250 lb. per square inch is 65,200 lb., or, with the trailing truck booster, 76,500 lb., but if the pressure is raised to 275 lb. per square inch, for which provision is made, the tractive effort will be 71,800 lb. and 84,200 lb. respectively.

The locomotives are fitted with type E superheaters, Worthington S type feed heaters, three syphons, two in the fire-box and one in the combustion chamber, a modified B type stoker, and a tangential steam separator which is fitted to the steam pipe in the dome. The main throttle is of the multiple-valve pattern, housed in the superheater header. A notable feature is the one-piece cast steel underframe, which includes the cylinders and saddle, and the absence of outside steam pipes will be noted, their place being taken by cored passages in the saddle. The frame casting is 58ft. 3in. total length, and has a weight of 72,500 lb. The boiler has a largest diameter of 100in. outside, where the plates have a thickness of $1\frac{3}{16}$in. There are fifty-one 2in. tubes, and 214 3½in. flues, and over the tube sheets the length is 21ft. The 27in. by 32in. cylinders have 14in. piston valves, and five engines have Baker gear, and thirty Walschaerts. Power reversing gear is fitted. The main connecting-rods are of the Woodard or articulated design, a construction which relieves the main pins of part of the piston thrust, and dispenses with the usual knuckle-pin arrangement in the side rods. The main and intermediate journal boxes have brasses of the adjustable three-piece type, and the bearings are 13½in. by 14in. for the main, and 12in. by 14in. for the others. Of the thirty-five locomotives, twenty-five have tender trucks fitted with the American Steel Foundries roller bearing units, and all the tenders have cast steel water bottom underframes, as illustrated by Fig. 13. The tank capacity is 18,000 gallons, and the fuel space is sufficient for 20 tons of coal, and, when thus loaded, the tender weight is 320,000 lb. Referring to the feed heater, it may be mentioned that the hot-water pump of the reciprocating pattern is seen arranged over the right-hand cylinder valve casing. The heater itself is just in front of the chimney. The sloping of the front of the cab is becoming common practice, as it materially adds to accessibility for the examination of the fire-box stay bolts.

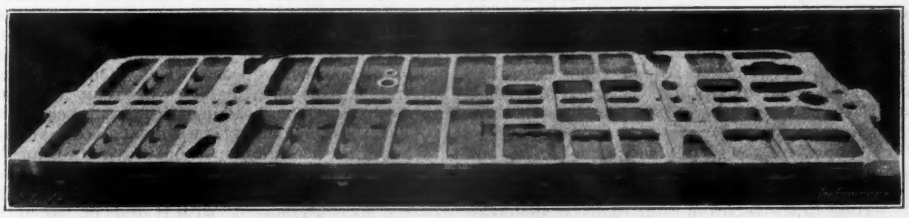


Fig. 13—Cast Steel Water Bottom Tender Frame, C.N.W. 4-8-4

As already pointed out, these locomotives are amongst the largest so far built for passenger service, and a few of the more important dimensions which will give an idea of their size are given as under :—

Height to top of chimney from rail	15ft. $11^3/_{32}$in.
Height from rail to boiler centre	10ft. 8in.
Driving axle wheel base	20ft. 6in.
Rigid wheel base	13ft. 4in.
Wheel base, engine	48ft. 7in.
,, ,, locomotive	91ft. 1in.
Total length over couplers	103ft. 4in.

Early in 1930 the Baldwin Locomotive Works delivered fourteen large 4–8–4 engines to the Great Northern (G.N.) for operating passenger trains on the more level sections of the line, and one is illustrated by Fig. 14. These locomotives, the leading dimensions of which are given in Table II., are remarkable for the large size of the coupled wheels, which have a diameter of 80in., the largest applied to an eight-coupled design. The boiler is of nickel steel, and has a large fire-box with combustion chamber, a type E superheater, and is fed by an exhaust steam injector. There are 195 3½in. flues, and thirty-eight 2¼in. tubes, and the length over the tube sheets is 22ft. The frames are of the normal cast steel bar type, and the cylinders are also of cast steel. Walschaerts' motion imparts a 7½in. full gear travel to the 14in. piston valves, and a power reverse gear is fitted. The working steam pressure is 225 lb. per square inch, and four valves are used; they are loaded to blow off at 225 lb., 226 lb., 227 lb., and 228 lb. respectively. The two 8½in. cross-compound air compressors for the brake are mounted on the smoke-box front and use superheated steam. A multiple-valve throttle is fitted. The leading truck has outside journal boxes, and is of a special design developed by the builders, having a one-piece framing of cast steel; the two side frames are connected to each other front and back, thus enclosing the wheels, and these end sections are braced to the centre by longitudinal stiffing members. The spring gear is equalised and the centering rockers are of the constant-resistance type. The leading truck wheels are 36in., and those of the trailing trucks of equal size are 45in. diameter. A tender of the Vanderbilt design is used, the body of which is welded throughout. It is mounted on a Commonwealth cast steel frame of the water bottom design. The six-wheeled trucks have cast steel frames. These locomotives use oil fuel, and there is tank capacity for 5800 gallons of oil and 17,000 gallons of water.

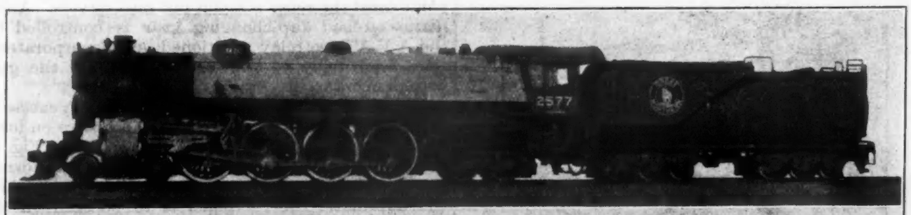


Fig. 14 (Above)—G.N. 4-8-4 Type Locomotive

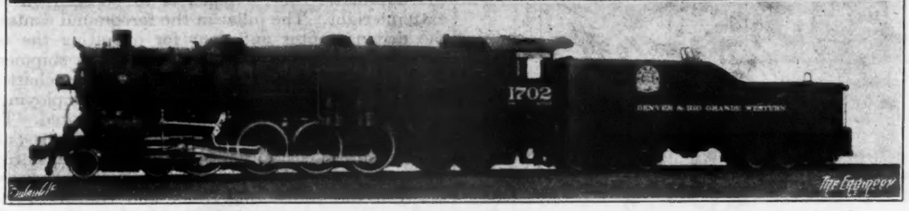


Fig. 15 (Below)—D. and R.G.W. 4-8-4 Type Locomotive

For working heavy passenger traffic over a very difficult road, the Denver and Rio Grande Western (D. and R.G.W.) utilise the class of engine shown by Fig. 15, built to the dimensions given in the table by the Baldwin Works. These engines are equipped with feed-water heaters, type E superheaters, Nicholson thermal syphons, power reversing gear, and cast steel cylinders. The valves, of the piston type, have a diameter of 14in., and are operated by Walschaerts motion, modified to provide variable lead which is increased as the gear is linked up. The arrangement is interesting, and is as follows. The upper end of the combining lever is slotted out to receive a die block fitted with a pin, which also passes through the forked end of the radius rod, which connects with the die in the expansion link. The pin engaging the radius link at the combining lever end is also long enough to engage with a short lifting link connecting with the horizontal arm of a bell-crank lever, the vertical member of which is, in turn, connected by a rod with an arm on the main reversing shaft. When the motion is in the mid-gear position, the arm on the reversing shaft, which is at 180 deg. with the lever operating the lifting links for the radius rod, has pushed the vertical member of the bell crank over slightly, and so raised the die block in the slotted end of the combining link, thus increasing the distance between the radius rod pin and the valve spindle centre, thereby adding to the lap and lead movement. The lead is, therefore, increased, but as the lever on the reversing shaft is opposite that controlling the lifting links, it follows that when the motion is put over into or towards either full forward or full back gear, the upper arm of the bell crank is depressed and the die in the combining lever, therefore, brought nearer to the valve spindle centre, thus reducing the lead opening. The bell crank and its connection with the die in the combination lever can just be made out in the illustration of the engine. The lead is zero in full gear, and increases to ⅜in. at 25 per cent. cut-off.

The boiler is of the usual round-top, radial-stayed description. It carries a pressure of 240 lb. per square inch, and has a fire-box fitted with a combustion chamber, and the grate has an area of 88 square feet. A mechanical stoker is provided. There are 195 3½in. flues, and forty-three 2¼in. tubes, and the length over the tube sheets is 22ft. The main journal bearings are 13in. by 14¾in., and those for the other coupled axles are 11½in. by 14¾in. For the leading truck the wheels are 36in. diameter, with journals 7in. by 14in., and for the four-wheeled trailer the wheels are 42in. with journals 9in. by 16in. Two 8½in. cross-compound compressors are fitted, and the air brake acts on all the coupled and the tender wheels. The tender, which runs on six wheels, carries 29 tons of coal, and has tank capacity for 14,000 gallons of water. The wheels are 36in. diameter, and the journals measure 6in. by 11in. These engines operate over the main line extending from Denver, Col., to Ogden, Utah, a distance of 782 miles, traversing the Rocky Mountain district, and crossing the Continental Divide at Tennessee Pass, 280 miles from Denver, at an elevation of 10,239ft. From the east the gradients are 1·42 per cent., and from the west the maximum gradient is 3 per cent. The track is laid with 100 lb. and 110 lb. rails.

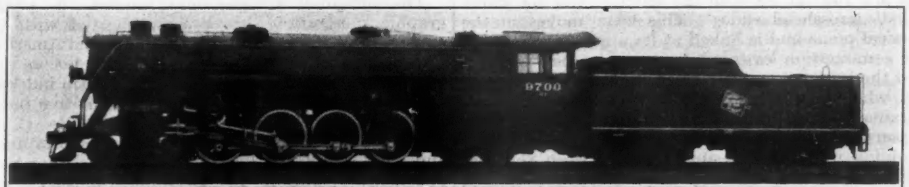


Fig. 16 (Above)—C. M. St. P. and P. 4-8-4 Type Locomotive

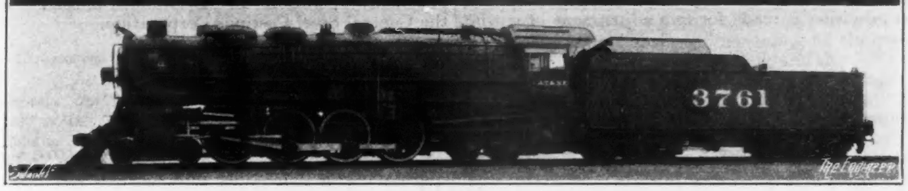


Fig. 17 (Below)—A.T. and Santa Fe 4-8-4 Type Locomotive

The next example of the 4–8–4 type is one for the Chicago, Milwaukee, St. Paul and Pacific (C.M. and St. P.), built by Baldwin in 1930—Fig. 16. The engine, in many respects, is similar to the "Pacifics," the main dimensions of which are given in Table I., and certain details, where practicable, are interchangeable. The engine has roller bearings for the front and hind trucks, and is replete with a feed-water heater, E type superheater, three Nicholson syphons, and stoker. The unit cast steel framing has the cylinders cast integral, and the "Pacifics" have the same type of frame construction. Laird type crossheads are common to both designs, and the valve gear is the same type, and arranged in the same manner. The boiler is of considerable size, and is fitted with a combustion chamber in conjunction with a fire-box of ample proportions, having the large grate area of 103 square feet. There are 218 flues, 3½in. diameter, and fifty-six 2¼in. tubes, and over the tube plates the length is 21ft. The boiler demand factor of 567 indicates considerable steaming power, relative to the horse-power capacity of the cylinders. The piston valves are 14in. in diameter. The tender carries 20 tons of coal and 15,000 gallons of water, and has roller bearings for the axles.

Both the C.M. and St. P. "Pacific" and "Modified Mountain" type locomotives are fitted with the Coffin feed-water heater, and the same is used also for the later "Hudson" type 4–6–4 engines of the N.Y.C. A short description of this heater will be of interest. The Coffin heater is of the closed type, and consists essentially of the heater and the feed pump units, both separate. The heater is semi-circular in shape, its radius being made to conform to the individual smoke-box to which it is applied. It is usually built into the upper part of the smoke-box, just ahead of the chimney, or it may be mounted outside at the front; but, owing to its shape, it is flush with the top of the box in either case. The semi-circular form allows of the tubes being fixed in rigid tube sheets as their curved shape naturally allows for expansion. The tubes are of copper. The water takes five passes through the heater, the first being farthest from the steam inlet, and the last directly next to the steam baffle. An auxiliary open heater is fitted in the tender. Its function is to combine the condensate with the feed water, and liberate dissolved oxygen. The pump is of the centrifugal pattern, turbine-driven by direct-coupling. It is placed below the tank level and usually mounted at the hind end of the engine under the footplate at one side where it is accessible for attention.

The Atchison, Topeka and Santa Fé (A.T. and S.F.) locomotive illustrated by Fig. 17 is probably the largest of its type for passenger service. The engine frame construction differs from that employed for any of the other engines described, in that the cylinders and valve chests are cast in one piece together with the saddle, and bolted and keyed to a one-piece cast steel bed frame. The cylinders are also of cast steel and special care has been taken with the form of the exhaust passages which are cored in the cylinder casting. It is claimed that, compared with cast iron, the use of cast steel for cylinders saves 25 per cent. in weight. All the coupled axles are hollow bored and so are the main crank pins. The big ends have floating bushings and the crossheads are of the Laird pattern. All the revolving and 50 per cent. of the reciprocating weights are balanced. The writer believes that this proportion of balance for reciprocating parts is usual American practice. The piston valves actuated by Walschaerts motion have a diameter of 15in. and the long full gear travel of 9in. when the cut-off is 85 per cent. The long valve travel is responsible for the inclusion in the valve gear of a novel means for overcoming unfavourable angles in the motion parts. This device, which magnifies the motion imparted to the valve for a given swing of the expansion link, consists of a short lever rocking about a fulcrum fixed in the outer end of the valve spindle crosshead slides. This lever moves in the vertical plane and is linked at its upper extremity to the combination lever, while at a point between this and the fulcrum, connection is made with the radius rod, which has the effect of increasing the valve travel obtainable for any given position of the die in the expansion link, thus maintaining a normal swing and avoiding unfavourable angularity between the link and the excentric rod. A power reverse gear is applied and provision is made for fine adjustment of cut-off by fitting a reverse gear quadrant with more teeth than usual. The boiler is of the radial stayed type and has a type E superheater, with header fitted with a multiple valve throttle valve. The blast pipe is very low in the smoke-box, and has a ported nozzle of the Layden type, designed for a large-diameter chimney. The tubes are fifty-seven in number and of 2¼in. diameter, and there are 231 3½in. flues. The length over the tube sheets is 21ft. The tender carries 20 tons of fuel and 15,000 gallons of water, the weight loaded being 292,260 lb. There are twelve wheels, having a diameter of 33in., and the axle journals are 6in. by 11in. The air brake acts on the coupled wheels of the engine and also on the tender wheels. These locomotives operate between La Juanita, Col., and Winslow, Arizona, 636½ miles, and between the latter point and Clovis, N.M., 503·5 miles, the last section being a mountain division. The mean speeds vary from 35 to 39 m.p.h. The trains are made up of nine to sixteen cars, equal to 793 and 1120 tons, and the engines make these division runs unchanged.

Referring to the tables of dimensions, it should be pointed out that the heating surfaces of the fireboxes in all cases includes that contributed by the combustion chamber and also, where fitted, the syphons and the fire-brick arch tubes. Weight, when given in tons, refers to tons of 2000 lb., and water capacities are all given in U.S. gallons.

Conclusion.

In presenting this review of recent design of express passenger locomotives as used in the United States no attempt has been made to go far into the details of construction, it being the writer's aim to give a general survey of the modern tendencies of design and to mention some notes on the fittings now included in American practice.

The information given and the various photographic illustrations have been collected with the assistance of the various builders, viz., the American Locomotive Company and the Baldwin Locomotive Works, and, in addition, the writer is much indebted to Mr. P. W. Kiefer, chief engineer of motive power and rolling stock, New York Central; Mr. G. H. Emerson, superintendent of motive power, Baltimore and Ohio; and Mr. F. W. Hankins, assistant vice-president, operation, Pennsylvania Railroad; and the General Steel Castings Corporation.

A.C. Voltage Regulators.

No. VI.

(Concluded from page 614, *December 22nd.)*

TWO types of induction regulator are made by the Metropolitan-Vickers Electrical Company. One is for capacities up to 100 kVA and for pressures ranging from the lowest to 3500 volts. The other for capacities in excess of 100 kVA and for voltages up to 15,000. Single-phase, polyphase, and twin regulators for overcoming phase shift are supplied for hand, remote and fully automatic control, according to requirements. Small polyphase regulators are generally employed under conditions which do not demand the elimination of phase shift, such as on a dead-ended feeder, but the Metropolitan-Vickers Electrical Company is prepared to supply twin regulators of low capacity if called for. Some of this company's induction regulators were described in our issue of April 16th, 1926. Since then certain modifications have apparently been made, notably in connection with automatic control. The latest relay for that purpose has two sets of contacts, one of which makes a circuit by a decrease of voltage. The other performs the same operation when the voltage increases. The opening and closing of the contacts controls the operation of two contactors, which determine the direction of rotation of the motor which controls the induction regulator-operating mechanism. It may also be made to control on-load tap-changing gear, the field regulator of a synchronous condenser, &c. As Fig. 62 shows, the coil A has a floating core B, attached to a beam pivoted at D, the weight of the core B being partially balanced by an adjusting spring E. At the end of the beam there are contacts F G. When the beam moves upwards, F touches H and when downwards G touches J. In circuit with the moving contacts is a small electro-magnet K, with poles L, which exert a pull on the armature N, thereby preventing chattering at the contacts. The movement of the core is damped by a dashpot O. By means of a spring connection between the dashpot plunger and the end of the pivoted beam, a quick break is ensured at the contacts. By the movement of the plunger the spring is compressed or extended, but owing to the pull of the magnet K the beam does not move until the spring, by overcoming the effect of K, causes the contacts to be snapped open.

When an induction regulator or tap changer is controlled by the beam relay the coil A of the latter is connected across the output terminals of the regulator. If the pressure does not exceed 500 volts it is connected directly, but if the circuit pressure is greater than that value it is connected to a fused potential transformer. A low tension supply is necessary to operate the regulator motor, and this may also necessitate the use of a transformer, although in some cases a local low-tension D.C. or A.C. supply may be used. A single operating transformer is never employed to supply both the motor and beam relay, as fluctuations, brought about by voltage drop due to the motor current in the windings of a small transformer, might affect the relay.

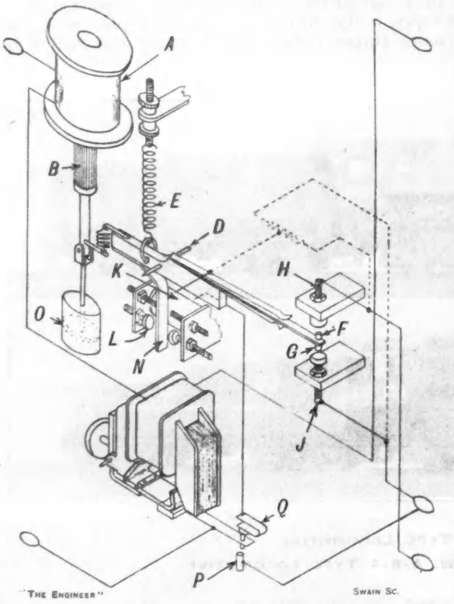


Fig. 62—Details of Balanced Beam Relay

A fall in voltage causes the core B to take up a lower position, with the result that a circuit is completed at H, and the associated controlling apparatus is put into action. Similarly a rise of voltage closes the contacts at G J. Relays of this kind are made in four types, designated A V, A V A, A W, A W A, and A V and A W differ electrically, the latter having a current winding on the control solenoid in addition to the voltage winding. This compounding of the regulator makes possible the introduction of a simple form of line drop compensation and introduces an equalising winding for use where several relays are working in parallel. The A V A and A W A relays have a no-volt element, to be seen below the relay. In the ordinary way, in the event of the supply voltage failing, the relay would close the circuit at H, and regulating mechanism might be moved to the maximum pressure position.

On the restoration of the supply, the system would therefore operate initially at maximum voltage, with possible serious consequences. But when the voltage fails the no-volt element closes a circuit at P and opens contacts Q thus bridging H, the result being that, provided the motor supply is still available, the voltage is reduced to the minimum value in readiness for the restoration of service. When the relay is energised contact P is normally open and contact Q closed. The latter is normally in series with H or J, but when the voltage fails this circuit is broken and contact P closes and causes the regulator to take up the position of minimum voltage. The circuit shown dotted is simply a centre-tapped resistance of high value connected across the relay contacts to minimise sparking when suddenly opening or closing the magnetic circuit of an additional time delay relay.

In the event of the relay shown being disconnected, owing, for instance, to the blowing of a fuse in the potential transformer or relay circuit, in the absence of the no-volt element there would be no control over the supply voltage, which might easily rise to a dangerous value with a fall in load. Under these conditions, however, the no-volt element would cause the voltage to be reduced to a low and safe value until the relay is again put into service. Automatic on-load tap-changing gear is controlled by the A V A type relay mentioned, and incorporates a time limit relay to prevent operation of the gear with momentary fluctuations of voltage.

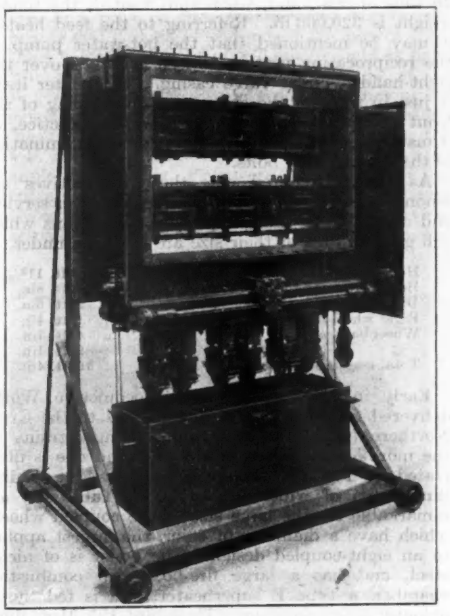


Fig. 63—On-Load Tap-Changing Equipment

For use on circuits working at voltages in excess of 33,000, or currents in excess of 100 ampères on-load, tap-changing equipment of the type shown in Fig. 63 is made. A 10,000-kVA, 33,000/6600 transformer fitted with this gear is shown in Fig. 64, in which the automatic control panel is to be seen on the extreme right. The pillar in the foreground contains the driving motor and gear for operating the tap changer, and it can easily be detached for shipment. A diagram of connections and sequence chart is shown in Fig. 65. The usual scheme of employing a reactor with a mid-point tapping is adopted. The selector " off load " switches are rotary switches, and are mounted either above the main transformer windings on insulators fitted to the dividing wall between the transformer tank and transfer switch tank, or in a pocket on the tank side above the transfer switch tank. Two of these switches are provided for each phase. The duplicate transfer switches and cam-operating mechanism are housed in a separate oil filled compartment.

Referring now to the diagram and sequence chart, Fig. 65, it will be perceived that the tapped portion of the transformer consists of sections T2 to T5, and the operating stages for the various tapping positions are indicated in the sequence chart. The transformer winding terminal 8 is connected successively to terminals T5 to T2 through the centre-tapped reactor. The number of voltages obtainable in this particular case is the same as the number of winding tappings, but if a large number of steps are necessary, the reactor can be made to double the number of effective tapping positions. Tapping position No. 1 gives the maximum voltage, and, as shown in the sequence chart, transfer switches X and Y are both closed, and the tap changers *x* and *y* are both in position 1.

Terminal 8 of the transformer winding is then connected to terminal 5 through the two short-circuited sections of the reactor. To reduce the voltage one step corresponding to position No. 2, transfer switch X is first opened, thus transferring all load to the circuit Y, tap changer *x* is moved to position II., and transfer switch X is closed. Transfer switch Y is then opened, thus transferring all load to the X circuit, tap changer *y* is moved to position II., and transfer switch Y is closed. Thus, the winding 8 is now connected to terminal T4, and, consequently, one tapping section is cut out. To reduce the voltage another step, corresponding to position 3, a similar process is followed during which the tap changers are moved from position II. to III. In all the main tapping positions both transfer switches are closed, and both tap changers are in the same position, so that the particular tapping in use is always connected to terminal 8 through the short-circuited halves of the reactor, and the reactive drop in these windings is eliminated. Each tapping change is brought about in a very short time by one revolution of the motor-driven mechanism.

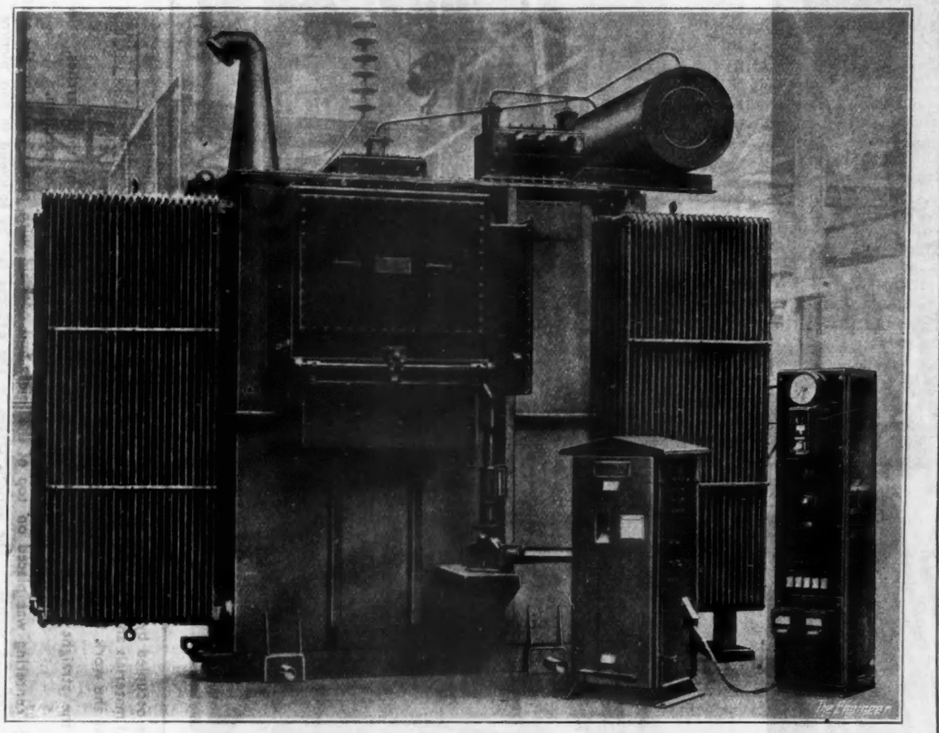
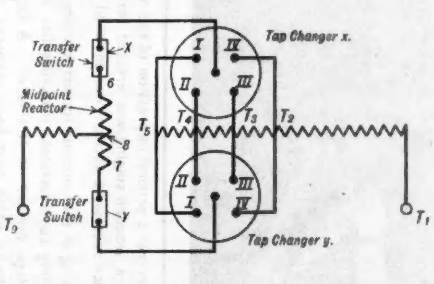


FIG. 64—10,000-kW ON-LOAD TAP-CHANGING TRANSFORMER



Tapping Position No.	1						2						3						4
Transfer Switch X.	0			0	0	0	0			0	0	0	0			0	0	0	0
Position of Tap Changer x.	I	I	II	II	II	II	II	II	III	III	III	III	III	III	IV	IV	IV	IV	IV
Transfer Switch Y.	0	0	0	0			0	0	0	0			0	0	0	0			0
Position of Tap Changer y.	I	I	I	I	I	II	II	II	II	II	II	III	III	III	III	III	III	IV	IV

0 Indicates "Switch Closed".

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FIG. 65—TAP-CHANGING CONNECTIONS

As is now well understood, during each half of the cycle the full load current is carried momentarily by one-half of the reactor winding, which, in the case of this tap-changing equipment, is designed to carry the full load continuously, so that if for any reason the tap-changing operation is not completed, it will not be overloaded. It will be equally evident that as at the end of the first half of the cycle the complete reactor is momentarily connected across two tappings, the line voltage is then raised by one-half of a step until the transfer switch Y is opened, when the voltage is increased by an amount corresponding to the full step. For lower outputs, *i.e.*, up to 100 ampères, another type of tap-changing gear is made, the circuit for which is given on page 85 of THE ENGINEER of July 26th, 1929, but the arrangement of the gear itself has now been altered. Mercury switch "on load" tap-changing gear is also supplied by the Metropolitan-Vickers Electrical Company for transformers up to 20 ampères and 11,000 volts.

ADJUSTABLE LINE DROP COMPENSATOR.

Reference was made in a previous article to line drop compensators, which enable the voltage of a feeder or transmission line to be regulated at the sending end of the line, so that the required voltage is maintained at the receiving end. It is necessary, in order to do this, for the regulating relay which controls the output voltage of the induction regulator or other arrangement to be connected in a circuit which accurately reproduces the receiving end conditions, as the regulation of the line will then be the same as if the controlling relay were at the terminal end. Various methods exist by which compensation may be made in the regulating relay circuit for the effects of impedance drop at different loads. The object of these compensating devices is to subtract vectorially from the voltage applied to the regulator (which is proportional to the sending voltage), a voltage equal to, but opposite in phase to the line impedance drop, the resultant voltage then representing accurately the conditions at the receiving end. To obtain a voltage representing the line impedance drop at different loads current transformers are connected in series with the load, and their output is fed to tapped resistances, the drop across which is subtracted from the voltage applied to the regulator coil by the voltage transformer.

By setting the resistances the voltage drop may be correctly adjusted, after which it will remain correct for all loads. As an alternative to this scheme, the output of the current transformers may be supplied to a current winding provided, in addition to the normal voltage relay winding, as incorporated in the Metropolitan-Vickers type A W relay, thus providing a number of ampère turns which are subtracted from those of the voltage winding, the operating flux being the resultant of the two. In order that the subtracted drop may be opposite in phase to the line impedance drop, provision is made for swinging it vectorially through a sufficient angle for adjustment by variation of the resistances, interconnection of the current transformers, or by similar methods.

Some of the commonly used compensating devices are not easy to adjust, so as to be fully effective for varying loads and different line characteristics. An adjustment of two interdependent variables is required, *i.e.*, that of the degree of compensation, and the phase, both of which should remain correct at varying loads. A line drop compensator developed by the Metropolitan-Vickers Electrical Company, however, is claimed to be an advance on other compensators. New features permit of an independent adjustment of the amount of compensation and of the phase angle. By the simple variation of resistance it is possible to adjust the phase angle to suit any particular line characteristic and then to vary the compensation separately to suit any variation in the length of the line which may be caused by the switching in and out of certain sections. At all loads the compensator faithfully reproduces the receiving end conditions at the sending end.

The vector diagram 1, Fig. 66, relates to the problem of voltage regulation on a transmission line. The voltage drop can be split up into two components I R, due to the resistance of the line in phase with the current; the other, I X, due to the reactance of the line, leads the current by 90 deg. The resultant of these two drops I Z bears a constant phase relation to the current vector, determined by the line constants, *i.e.*, by the ratio of resistance to reactance, and its magnitude is proportional to the current. It therefore exerts a varying effect on the received voltage for a constant load, depending on the power factor of the load, as shown in diagram 1.

The manner in which a vector voltage is obtained corresponding to the line impedance drop and opposite in phase to it is shown in diagrams 2 and 3.

Diagram 3 represents a network of resistance fed from two current transformers R and B at the sending end. The resistance A C=resistance C D, and E H is twice the resistance A C. The slider P can be moved anywhere along A D and it is evident that the red transformer R will circulate a constant proportion of its total current in E H, while the blue transformer B will circulate a varying proportion of its total current in the resistance E H dependent on the position of P. The direction of the "blue current" in E H will be determined according to whether P is on the left or right of C. The resultant voltage across E H is determined by the resultant current in E H, *i.e.*, the vector sum of the current in E H due to the red current transformer and the current in E H due to the blue transformer. The variations in this resultant current produced by varying the position of the slider P are apparent from the vectors in diagram 2, in which O I_R and O I_B represent the secondary currents in the two transformers. O C represents the fixed proportion of "red current" which flows in E H.

The proportion of "blue current" flowing in E H depending on the position of the slider P will take up a series of values such as O Q, O P, O R, O S, &c., and

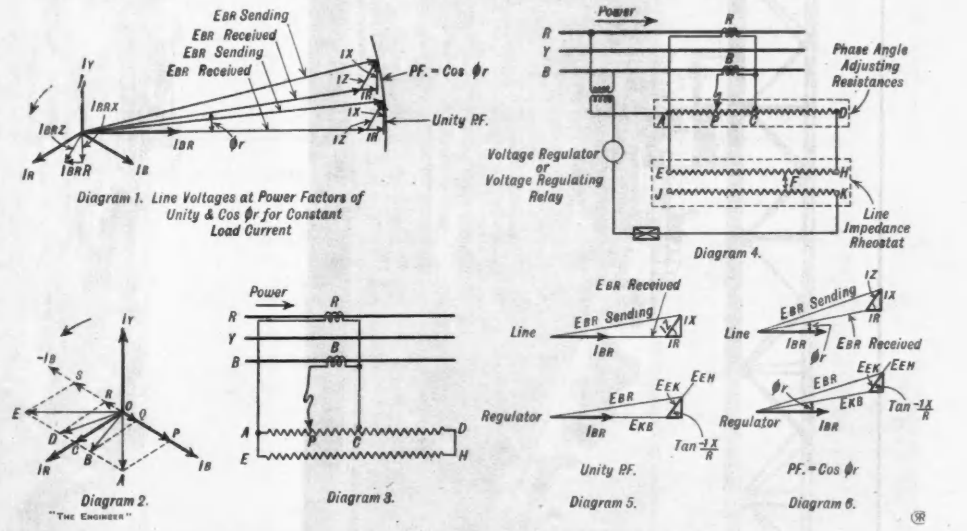

FIG. 66—LINE DROP COMPENSATOR DIAGRAMS

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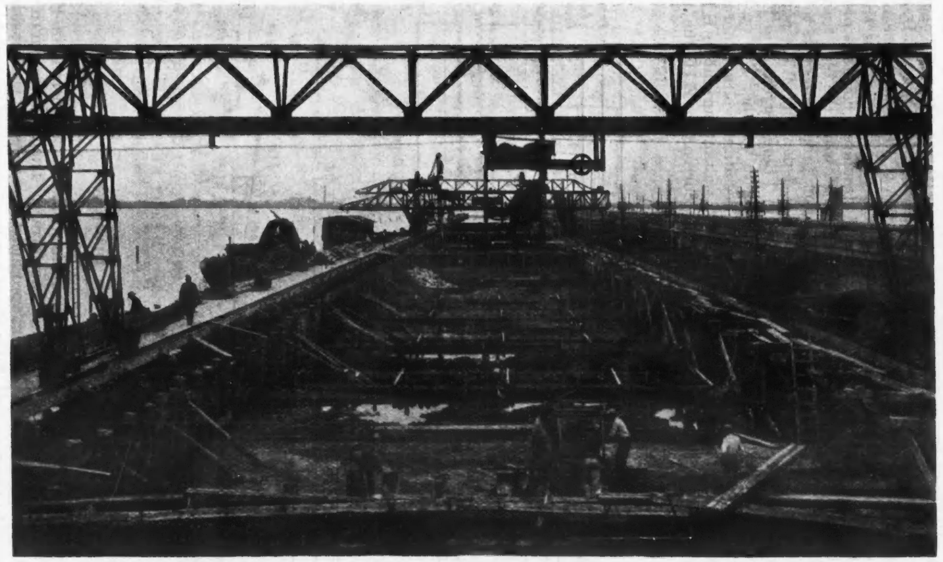
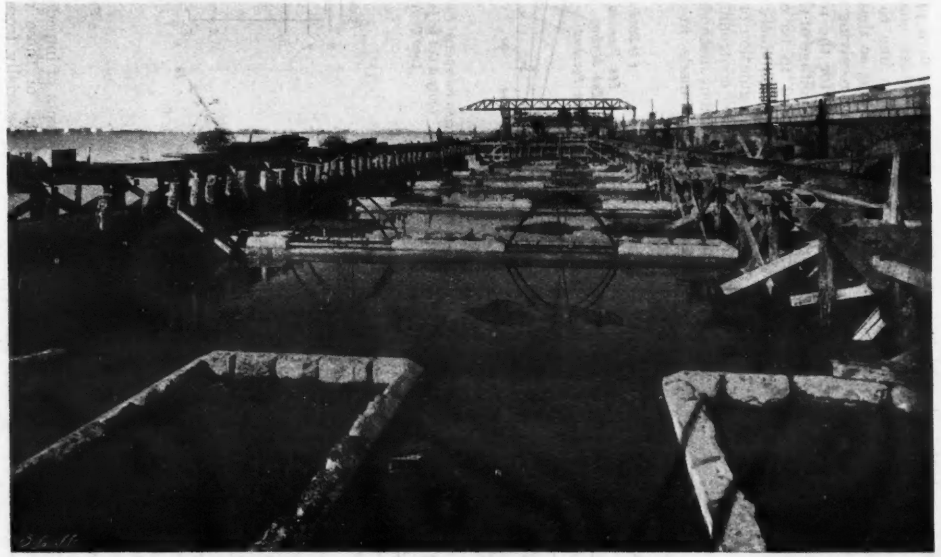
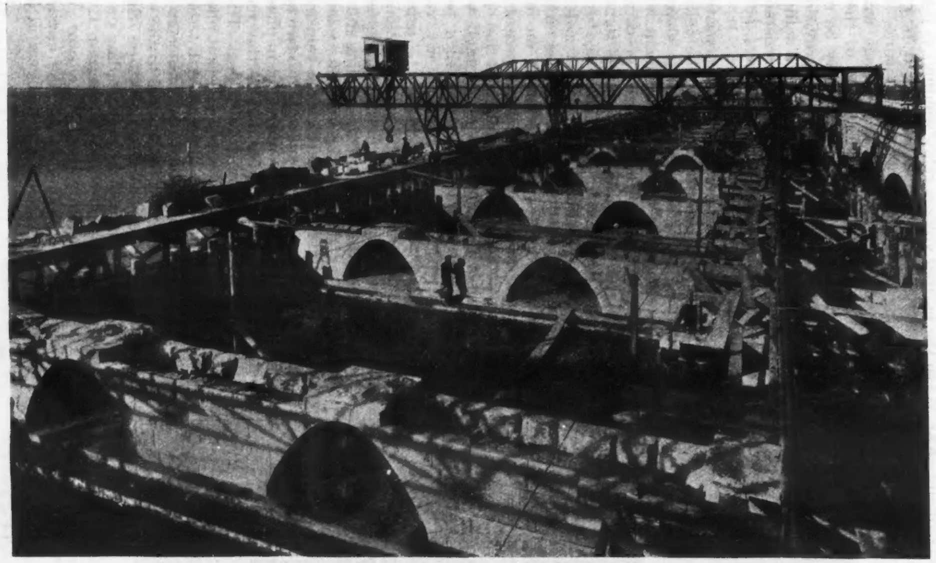
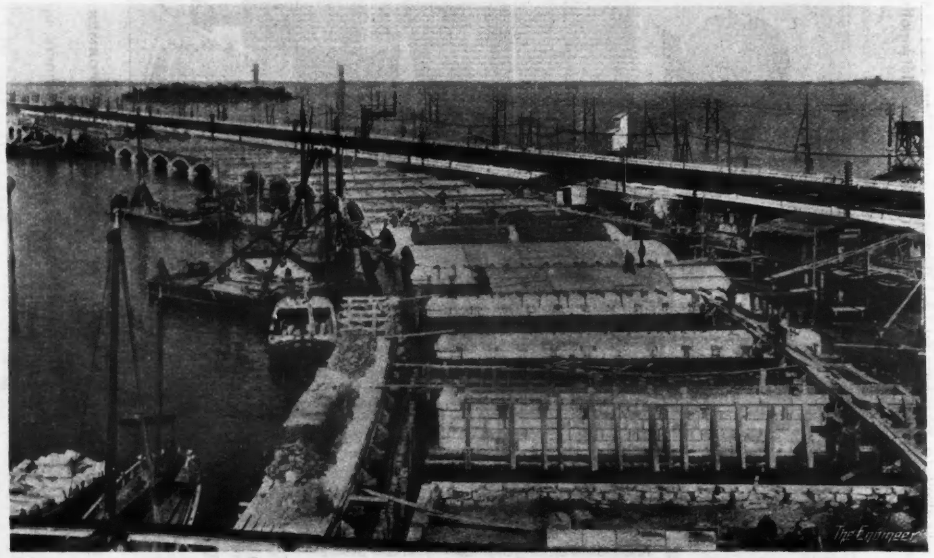
(For description see opposite page.)









From these pictures a general impression of the methods of construction adopted can be gained. The space occupied by a group of arches was enclosed within a cofferdam. Outside the cofferdam a wooden staging was erected forming a landing stage for the barges bringing constructional materials and a support for the rails of travelling cranes. As construction progressed each successive section was enclosed within the cofferdams, which were removed as and when the work in each section had reached a height above the water level.

Above :—In this picture work upon the laying of the concrete foundation blocks upon the previously driven piles can be seen. One of the barges bringing constructional materials lies beside the wooden landing stage.

Below :—Operations have proceeded a stage further in this view. A facing of masonry has been laid on the concrete foundation blocks which have been prepared to receive the piers.

Above :—On the straight part of the bridge each of the piers was pierced by three arches. In this view a number of the piers can be seen in various stages of erection.

Below :—Steel centering was placed on top of the piers and overlaid with planks ready for the erection of the brickwork arches. The various stages in the process can be followed in this picture.

the resultant current in E H will take up corresponding positions O A, O B, O C, O D, O E. The line A E is therefore the locus of the resultant current vector in E H caused by moving the slider of coil B in diagram 3. When the slider P is at A, O P in diagram 2 equals O C and the resultant current is O A lagging 90 deg. behind I_{BR} (diagram 1). When P is at C in diagram 3 no current from the blue current transformer flows in E H; hence the resultant current in E H is O C, diagram 2. When P is at D in diagram 3 the "blue current" in E H is reversed and is equal in magnitude to the "red current." Hence the resultant current in E H is O E (diagram 2), 180 deg. out of phase with I_{BR} (diagram 1). By moving the pointer P it is therefore possible to make the phase of the resultant current in E H and consequently the resultant voltage across E H vary from 90 deg. lagging I_{BR} to 180 deg.

At some position of P this voltage may be made exactly equal to the line impedance drop, but opposite in direction, the magnitude of the voltage so obtained being proportional to the load current I_{BR} and to the values of the resistance A C and P C.

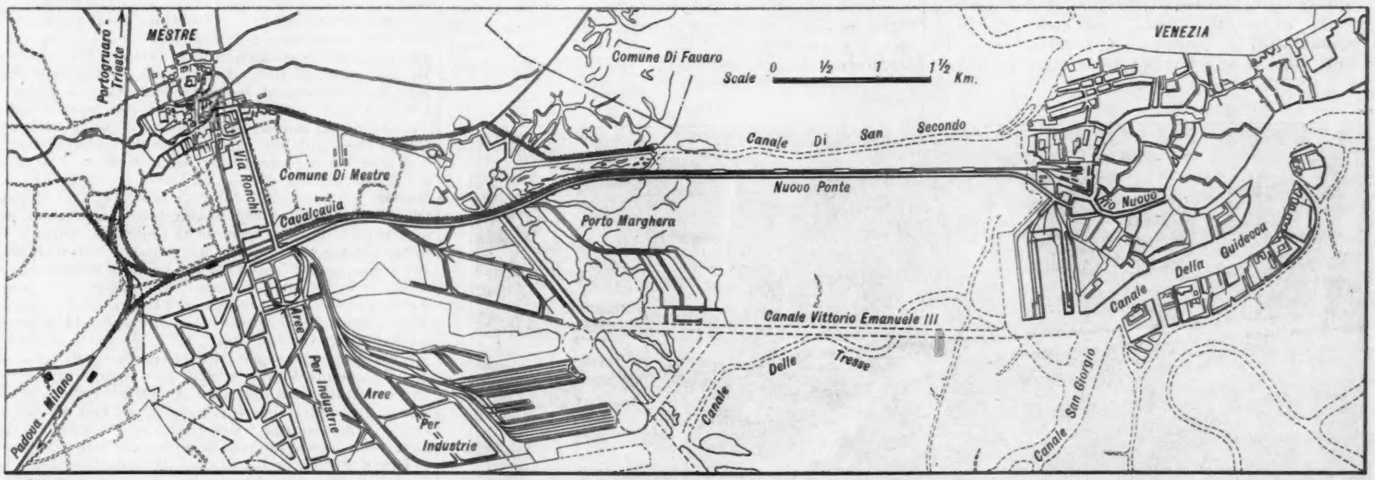
Referring now to the diagram 4, Fig. 66, by the addition of a resistance J K and a slider F a potentiometer device is obtained so that any portion of the voltage across E H may be tapped off, giving a voltage across E K variable in magnitude but not in phase. The resistance J K is equal to half E H, and is so graded that on moving F the resistance between A and K remains constant. Once the position of the slider P has been fixed according to the ratio of resistance to reactance in the line, the voltage across E H is directly proportional to the load and 180 deg. out of phase with the line impedance drop.

By suitable adjustment of F it is therefore possible to obtain a voltage across A K which is exactly proportional to and 180 deg. out of phase with the line impedance drop under all conditions of load and power factor. By subtracting this voltage from the sending end voltage E_{BR} (stepped down by a potential transformer) in the same way as the line impedance drop is subtracted from the sending end voltage a resultant voltage E_{KB} is obtained which is directly proportional to the receiving end voltage under all conditions of power factor and load. If this voltage be applied to the voltage regulating device at the sending end the regulator will operate to maintain constant voltage at the receiving end.

The complete connections for producing this result are shown in the diagram 4, Fig. 66, from which it will be apparent that the voltage E_{KB} is applied to the regulator. Diagram 5 shows the conditions on the line and on the regulator for a load of unity power factor, and diagram 6 the corresponding conditions for a load at some power factor cos φr. From these two diagrams the exact correspondence between the received line voltage and the regulator voltage is evident. The compensator has the advantage of complete flexibility, in that the magnitude of compensation is adjustable independently of the phase of the compensation, and for this reason the combination of resistances A C D is called the phase angle adjusting resistance, while the combination E H J K is termed the line impedance rheostat. The scheme may be equally well applied to an automatic voltage regulator or to a voltage regulating relay. As described, the compensator is only applicable to polyphase circuits, but by suitable arrangements for obtaining the swinging vector corresponding to line impedance drop it can be used on single-phase systems.

The Mestre-Venice Viaduct.

Amongst the many great public works executed in Italy during the last few years, the construction of the Bridge Road from Mestre to Venice ranks among the first in importance, both as a fine piece of engineering, as well as by the consequences it is believed it will have on the life of one of the world's most famous towns. The geographical position of Venice as an island is well known, and requires no further description. The only connection previously existing with the mainland was the railway bridge from Mestre, which was built in the years 1841–45 by the Austrian Southern Railway, Venice belonging at that time still to Austria. The steamboat services of Venice, which take the place of tram services in other towns, provided another connection with the mainland.



"The Engineer"

This plan shows the position of the new bridge on the south side of the railway; the situation of the new canal—Rio Nuovo—in Venice itself; and the means of access from Mestre to the head of the bridge.

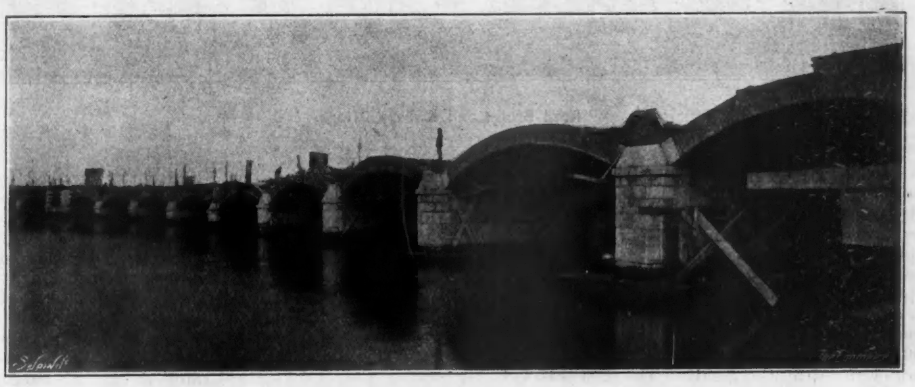
The idea of connecting Venice with the mainland by a road bridge was not new, and, particularly since the opening of the railway bridge, had been discussed on many occasions, without, however, being thoroughly investigated by any responsible body. Amongst the factors which greatly influenced the ultimate decision to build the viaduct was the development of Porto Marghera, which before the war was a stretch of waste land with a few lonely fishermen's huts, and which to-day might be termed the industrial suburb of Venice, laid out on the most up-to-date principles of town planning and having over forty important manufacturing establishments. Venice, with its restricted area, offers no possibility for industrial expansion, and the whole activities in this direction have been transferred to Porto Marghera. It is interesting to note that all previous projects, including the one recommended in 1921 by the Provincial Council, carried the bridge to the north of the railway bridge. But when in 1929 the final decision came to be made, due consideration was given to the position of Porto Marghera, and it was decided to place the viaduct on the south side of the railway bridge so as to bring Venice within closer and more direct reach of Porto Marghera (see map). This decision also facilitated the task of laying out a suitable approach road and terminus square in Venice itself. In this connection the very important question of a central garage had to be considered, and in the selection of a suitable site for its erection allowance had to be made for a sufficient space for a public parking place. The absence of any roads or streets in the usual sense—there are merely lanes and alleys in Venice interconnected by innumerable little bridges—excludes *a priori* the possibility of building a number of garages in different quarters of the town for private and public use. It became therefore incumbent upon the municipality of Venice, which built the Bridge Road, to make the necessary provision for centralising all services connected with the garaging of cars in one building suitably located at the termination of the Bridge Road itself.

Another problem of considerable importance arose in respect of the maritime station of Venice, which had to be brought for obvious reasons into direct communication with the new road, not only for allowing the important road transport traffic to reach the docks and unload alongside the steamers, but also in view of the important passenger traffic of the various steamship lines from Venice. Finally, the speeding up of traffic inside the town was considered. The main artery of Venice is the famous Canal Grande, which begins beyond the railway station and runs in the shape of an inverted S to St. Marks. Its length is 3300 m., and there is a regular service of small steamers running from one end to the other. It had long been felt that an abbreviation of this route would be an improvement. It was therefore decided to cut a new canal, the Rio Nuovo, through the larger section of the inverted S at a point adjoining the terminus square. This new canal has a length of 700 m., and as the larger half of the S is 2400 m. long, a saving of 1700 m. is effected.

Signor Miozzi, Chief Engineer of the Municipality of Venice, who was in charge of the whole construction and execution of the work, and to whom we are indebted for much of the information included in this article and many of the illustrations, blended the requirements with great skill.

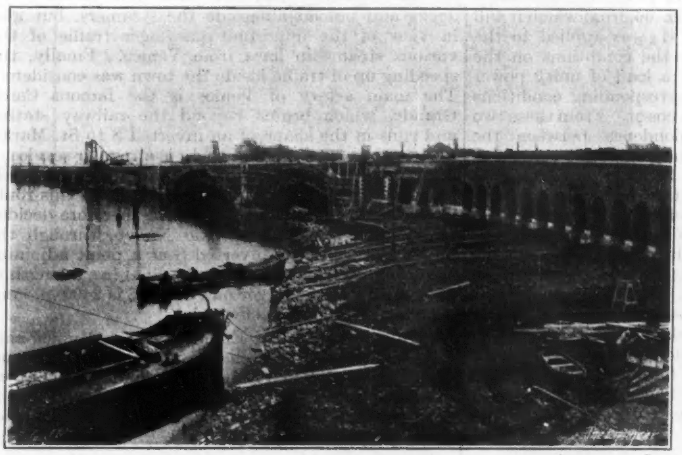
The new road begins at Mestre close to the railway viaduct. The spot has been well chosen, being the junction of all main roads leading to Mestre from various directions. One of these roads will be the Turin–Trieste Autostrada, several sections of which are already built. The Bridge Road runs for about 5 kiloms. on the mainland almost parallel to the railway. Over this stretch it has a width of 22 m. The parapet and footway on the lagoon side occupy 3·5 m., and the footway on the other side 2·5 m., leaving a clear width of 16 m. for motor traffic.

The bridge proper begins at the lagoon. It is composed of a series of arcades which are placed coaxially with the railway bridge and repeat the disposition of piers. An interspace of 2·25 m. is left between the two bridges, partly to facilitate construction and partly to prevent the stability of the railway bridge becoming endangered. This interspace has been covered with a layer of concrete forming a footpath

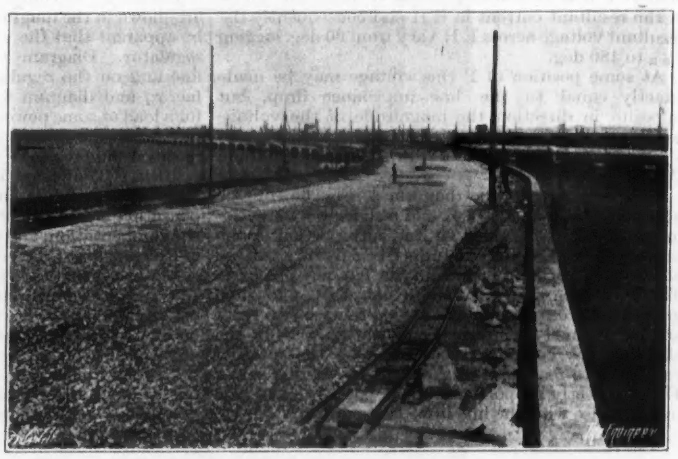


This illustration supplements one of those on page 640 in showing the method of constructing the brickwork arches.

on this side of the bridge, a corresponding footpath of 3 m. width running on the opposite side of the road. The parapet on the lagoon side occupies 0·5 m. The clear width of the road for motor traffic is 15·75 m., the total width of the bridge being 22 m. The viaduct consists of 228 arches built of bricks and cut stone, each arch having a span of 10·63 m. The arches are arranged in groups of five, separated by main piers, 8·65 m. wide. The central arcade has seven arches, and the main piers at each end are 13·73 m. wide. The smaller piers supporting the arches have a width of 1·50 m., and a height of 2 m., and are supported on foundation blocks 1 m. in height and 3 m. in width, which in their turn rest on concrete piles of varying length driven into the bottom of the sea. There are five rows of piles, each containing eighteen piles placed at a distance of 1·09 m. and 1·35 m. from one another. The piers are composed of three parabolical arches of 3·29 m. span and 1·79 m. height, the centre abutments being 3·39 m. wide at their base.

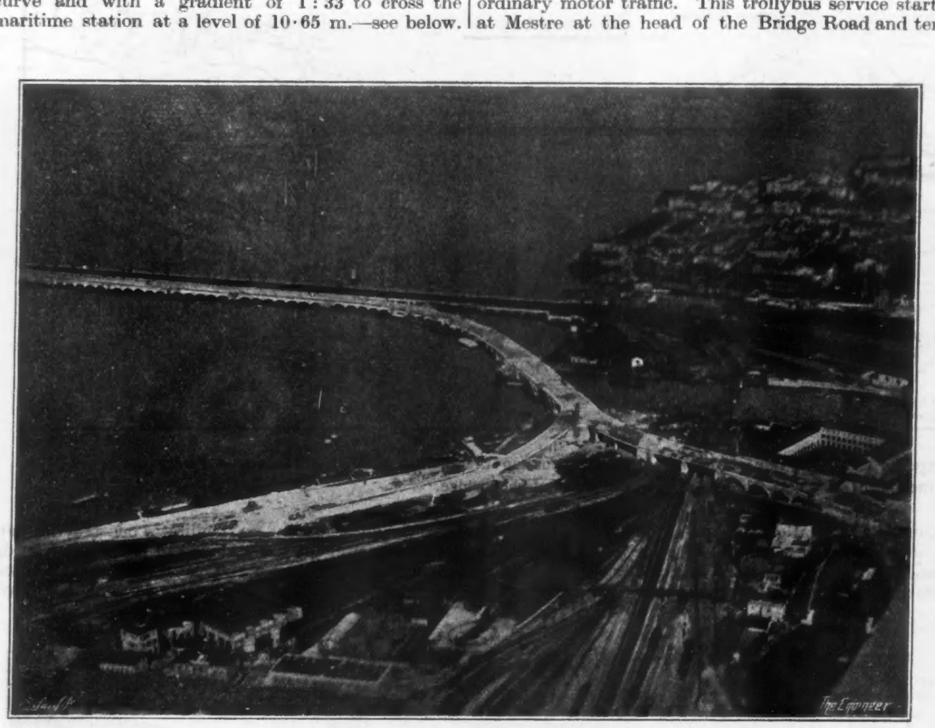


The Venice end of the road. The two arches in the centre of the picture carry the road over the Canale Grande. The viaduct on the right carries a branch road down to the docks.



In this illustration the noble width of the bridge can be appreciated. The bridge proper is completed and the road is being surfaced.

The footway of the viaduct is 3·36 m. above sea level. At Arch 220 the Road Bridge curves away from the railway bridge, crosses the Canal Grande on two arches of 34 m. span each, and continues in a curve and with a gradient of 1 : 33 to cross the maritime station at a level of 10·65 m.—see below.



Road Bridge and Railway Bridge.

A new road leading to the maritime station branches off at the landward end of the canal bridge. The Bridge Road subsequently crosses the marshalling yard on a viaduct of five arches, of which four have a span of 20 m. and the other a span of 9 m. It then crosses the Canal Scomenzera on a viaduct of 20 m. span and reaches with a down gradient of 1 : 33 the terminus square, called Piazza Roma, where the garage is being built. The square covers an area of 40,000 square metres, of which 9000 square metres are occupied by the garage. The area was formerly occupied by a number of old tenement houses of no artistic value, sports grounds, vegetable plots and sheds. As will be seen from the accompanying map, ample accommodation has been left for parking public and private cars on the square.

The new canal "Rio Nuovo," begins at the Canal Grande and adjoins Piazza Roma on one side and the famous Papadopoli Gardens on the other side. The whole quay of the Canal Grande between the Canal Scomenzera and the Rio Nuovo, a distance of 700 m., has been newly constructed and landing-stages for the steamer service, motor boats, gondolas, &c., have been provided. The Rio Nuovo has a length of 700 m. and an average width of 15 m. Its construction necessitated the building of a number of new bridges and other structural alterations, all of which were carried out without interfering with any building of artistic or historical interest.

The agreement between the Government and the municipality for the construction of the Bridge Road stipulated that there should be an electric tram line to Mestre. It was found, however, that such a tram line requiring a double track would occupy 7 m. width, reducing the available space for motor traffic to 9 m., which was considered to be insufficient. To suit local conditions, the best solution was found in an electric overhead trollybus service, which allows perfectly free movement without interfering with ordinary motor traffic. This trollybus service starts at Mestre at the head of the Bridge Road and terminates in Piazza Roma. Current is supplied from the transformer sub-stations at Venice and Mestre through mercury vapour arc rectifiers.

The garage is in course of construction, and will be built in two stages, the first of which is already completed. It has a length of 100 m. and a height of 23 m., and contains, besides a basement floor, five upper floors. The basement floor is reserved for cycles, motor cycles, repair and workshops, stores, &c. The upper floors are reached by a ramp of 4 m. width, a second identical ramp serving for outgoing cars. The average width of the curves is 8·60 m. and the gradient 1 : 16. The front part has accommodation for 900 cars, and the rear part of the building, when completed, will have accommodation for the same number of cars, so that on completion a total of 1800 cars will be able to park in this garage. The building on completion will have a floor space of 50,000 square metres. The erection of the front part necessitated the excavation of 4500 cubic metres of earth, and over 7000 cubic metres of concrete and 700 tons of iron were required.

The first foundation pile for the construction of the bridge was driven at the beginning of July, 1931, and the completed Bridge Road was opened for traffic on April 25th, 1933—after twenty months. The total cost amounted to 80 million lire (£1,230,000). On page 640 and accompanying this article a number of photographs illustrating the construction of the bridge are reproduced.

SIXTY YEARS AGO.

In our issue of January 2nd, 1874, some authentic information is to be found concerning the history of the first Bessemer steel rail—which incidentally was also the first cast steel rail—ever laid down on a railway. The information was contained in a letter to the editor from Mr. Robert F. Mushet. In the early part of 1857 Mushet cast some blooms of Bessemer steel for the Ebbw Vale Iron Company. Some of these blooms were rolled into double-headed rails at the company's Victoria Ironworks. One of these rails was sent to Derby Station, where it was laid down at a point of maximum traffic. The rail was still in service in 1867, and on December 26th of that year Mushet wrote to Mr. John Crossley, of the Engineer's Office, Midland Railway, asking how many trains passed over it each day and whether the railway company would dispose of the rail to him. Mr. Crossley replied that about 250 trains passed daily over the rail and at least the same number of detached engines and tenders. He was disinclined to recommend the sale of the rail, but he promised Mushet that if it were ever taken out he would be given the refusal of it. On June 16th, 1873, Mushet again wrote to Mr. Crossley, who replied, expressing his regret that about ten days before Mushet's letter had been received the rail had been taken out and used up. Mushet thought that it was a great pity that this historic rail had not been preserved. A hundred years later, he remarked, it might have been worth thousands of pounds and have been an object of interest and curiosity. He called attention to the fact that the rail had had a life of sixteen years and that during that time about one and a-quarter million trains and an equal number of detached engines and tenders must have passed over it. He did not know how long an iron rail placed at the same point would have lasted, but its life would certainly not have been sixteen months, probably not six months. . . . Even in those days efforts were being made to improve on Bessemer steel for railway track work by the devising of a practical and economic method of alloying manganese with iron. Processes by Prieger and Henderson, both founded on the simultaneous reduction of a mixture of pulverised iron and manganese ores, had been tried, but in both cases the output was small and the fuel consumption enormous. In the issue above referred to we noted a new process devised at the Terre Noire Ironworks in France. Under this method filings or turnings of iron, steel, or cast iron were mixed with pulverised ores containing manganese, tungsten, or titanium. The mixture was thoroughly moistened with a solution of ammonia or slightly acidified water and was then compressed in an iron mould. A large amount of heat, it was stated, was thereby evolved, and on opening the mould some hours afterwards it would, it was asserted, be found to contain a very hard mass, which could be broken into fragments by means of a hammer. The fragments were subsequently treated in a blast-furnace. Alloys containing anything from 25 to 50 per cent. of manganese or other percentages of tungsten or titanium could be produced in this manner, so it was stated. The temperature required in the furnace, it was noted, was very high and the blast had to be injected very hot and under great pressure. Special provision had therefore to be made to enable the furnace to withstand these trying conditions. The fragments were deposited in a crucible composed of carbon, lime and manganese, and the furnace itself was built of very hard fire-clay bricks lined with lime, manganese, or pure alumina.

Railway and Road Matters.

The traffic receipts for the forty-ninth week were noteworthy in that the Great Western joined the Southern in reporting an increase in the total receipts for the year. The L. and N.E.R. was, moreover, only £170,000 down. The L.M.S. decrease was £503,000 for the year.

The statistics for the German State Railways give an excellent record as to railway accidents. In the years 1930, 1931, and 1932 the number of passengers killed in train accidents was three, one, and three respectively. There was, too, an improvement each year in the fatalities to passengers, other than in train accidents; those figures were 109, 91, and 56.

During shunting operations on the morning of Tuesday, December 19th, a goods brake van ran back in the wrong direction at Hellifield Goods Yard box on the former Lancashire and Yorkshire Railway. Unfortunately, a goods train from Manchester to Carlisle was in the section, and it collided with the brake, causing the engine of the goods train to be derailed and thrown down an embankment. The driver and fireman were killed.

The retirement at the end of the year of Mr. A. S. Bailey, the managing director of the Metropolitan-Cammell Carriage, Wagon and Finance Company, calls for mention in this column, inasmuch as he was essentially a railway man. Mr. Bailey started in the Lillie Bridge shops of the Metropolitan District Railway in October, 1883, but gained most of his practical experience at Nine Elms, on the London and South-Western. After two years as an inspecting engineer for Sir Alexander Rendel, he went, in 1897, to the East Indian Railway, where, among other events, he superintended the construction of the first locomotive to be completely built in India. From 1904 to 1912 Mr. Bailey was chief mechanical engineer of the Bengal-Nagpur, and on his return to England joined Cammell, Laird and Co.

The Railway Returns for 1932 show that during that year the locomotives of British railways consumed 11,699,515 tons of coal, and 31,476,474 pints of lubricating oil, as compared with 12,266,825 tons and 33,209,776 pints respectively in 1931. The amount of coal consumed per engine-mile by steam locomotives was 52·39 lb. in 1932, and 53·12 lb. in 1931, whilst the average of the lubricating oil was 6·28 pints per 100 engine-miles in 1932, and 6·41 pints in 1931. There was a decrease in 1932, as compared with 1931, of 7·15 per cent. in the total wagon miles worked. The average number of wagons per train decreased from 34·12 to 33·57, but the proportion of the loaded wagons per train rose from 66·44 to 66·53 per cent. The average wagon load for all descriptions of traffic decreased from 5·50 to 5·42 tons, and the average train load from 124·73 to 121·00 tons.

The introduction of colour-light signals, wherein the day indications of "danger," "caution" and "clear" are given by red, yellow, and green lights, as at night, drew attention to the comparative powers of the light given for the night indications of the customary semaphore signal. That was a point made by the 1927–1930 Automatic Train Control Committee, and greater attention is now being paid to signal lamps. The tail lamps carried by the last vehicle of trains now need more consideration in view of the abolition of the side lights which were additionally carried. The two firms principally engaged on the manufacture of railway lamps have been the Lamp Manufacturing Company and the Railway Supplies Company, and as these have now recently been amalgamated, the desirable improvements in signal and train lamps should be more readily and effectively obtained.

In announcing its works and rolling stock programme for the year 1934, mentioned herein on December 15th, the London, Midland and Scottish Company says that with the completion of that programme the company will have spent £100,000,000 on large replacements and improvements. The best index, it says, of the increased efficiency which has been secured by this policy is provided by the locomotive position. While 2500 new locomotives have been built or ordered, the corresponding number of engines withdrawn from service is 4800, indicating greater efficiency not only of the engines themselves, but of the method of their employment so as to obtain the maximum use of each locomotive. The number of different types of locomotive in the company's service has been reduced from 393 to 204, while the number superheated has been increased by 2000, or more than doubled. These changes have enabled heavier trains to be hauled at higher speeds, and reduced coal consumption and repair cost per mile.

The terrible disaster of Saturday evening last, near Lagny, on the Eastern Railway of France, by which some 200 passengers lost their lives, has revived an old saying that there always is a bad railway smash at Christmas time. In the late 'seventies it did really seem as though that was so. The Shipton-on-Cherwell disaster of December 24th, 1874, when thirty-four passengers were killed as a result of a broken axle, began this series. An unusual snowstorm led to the double collision and the loss of fourteen lives at Abbotts Ripton on January 21st, 1876, whilst at Arlesley, on December 23rd, 1876, four passengers were killed, when an express overran the signals and collided with a goods train. The Tay Bridge disaster, with its seventy-three fatalities, came on December 28th, 1879, and the series ended on December 21st, 1880, when, at the Midland station at Leeds, an outgoing train was allowed to leave on the arrival line and in the head-on collision that resulted four passengers were killed. For a spell of nineteen years the association of serious railway accidents with Christmas found no warrant, and then, on December 23rd, 1899, the up Newhaven Continental boat train, when standing at Wivelsfield in a dense fog, was run into by an express from Brighton to Victoria and five passengers killed. In none of these six cases, though, was the excess of traffic at Christmas the main nor even a contributory cause, and it was not until, and as recently as, December 24th, 1910, that, at Hawes Junction, on the Midland Railway, the heavier traffic of the Christmas of that year led to two light engines, coupled together, being left on the down main line and overlooked. These were run into by an express and twelve passengers lost their lives.

Notes and Memoranda.

Copper containing about 2·5 per cent. of beryllium is being used in America as an alloy for making small boat propellers. It is said to permit a reduction in the thickness of the blades by 25 per cent.

A vertical lift bridge has been built at the freight wharf of Kawasaki Harbour, for the South Manchuria Railway Company, entirely by arc welding. It has a span of about 69ft. and a lift of 30ft. The job required the making of over 4000ft. of welded seams, but the total cost was only £1300.

The Kommerer Coal Company, Wyoming, recently had to build a bridge across a gully in order to get coal from one of its pits to the loading yard. It had, says *Electric Welding*, on hand a considerable accumulation of scrap 10in. steel pipes and rails from closed mines. The engineers designed and built a bridge out of this scrap by welding. The bridge is 393ft. long, supported about 100ft. above the deepest part of the gully, and capable of carrying the coal trains. As the scrap material had all been written off the books, the money cost of the bridge was little more than that of the electrodes, labour, and the current used.

A new method of producing X-rays by using heavy and relatively slow-moving particles of electricity instead of the usual fast-moving light electrons, has been discovered by Dr. W. M. Coates, of the University of California. His method is to use mercury ions. The energy obtained from these particles (which have a low velocity by comparison with electrons) is very large and is given in small repeated acceleration. Positive mercury ions at 2,400,000 V are allowed to strike targets of various elements, thus producing X-rays. It was found that these heavy ions produced ten times as many X-rays as do 3000 V electrons.

In comparing the planer and the milling machine, we should, says Mr. F. E. Cardullo, in *The Iron Age*, compare only machines of modern design. Most planers and many milling machines now in use are of obsolete design. Under favourable conditions, a planer of medium or large size will remove metal from work of suitable size at a faster rate than a milling machine, and less work is expended in removing the metal, because tools of better form may be used, coarser feeds may be employed, the planer tool does not distort the chips as much as the milling cutter, it does not cut the chips into fine pieces, and it does not abrade the work with the chips. When a relatively small proportion of the surface of the work is to be finished, the planer usually works at a disadvantage, using more power and doing the work less rapidly than the milling machine.

In an article on "Gas Fuel for Electrical Generation," *Heat Treating and Forging* states that a few years ago most of the steam-powered generating plants in Southern California were considered as stand-by units for the hydro-electric systems, but this position has now been reversed. The present tendency toward steam rather than hydro-electric generation is due largely to improvement in steam plant efficiency and in part to the use of the large available supply of fuel—natural gas. The demand for gas for domestic use is very seasonal, being high in the winter and low in the summer. The electric load of the Edison Company is high in the summer and low in the winter. This condition, combined with the fact that there is more stream flow hydro-electric power available in the winter, presents the possibility of a high annual load factor for gas transmission lines serving the dual purpose of supplying both gas and electric utilities.

It is of importance for practical purposes to know the magnitudes of the experimental errors to be expected in the analysis of coal and coke. It is only when these are known that it is possible to state whether differences in results are due to the inevitable experimental errors, or to a true difference in the substances under examination. A report just issued by the Department of Scientific and Industrial Research deals with the general principle of the Probability of Errors and its application to analytical practice. The probable error of the various routine analytical determinations for coal and coke are deduced and their implications discussed. The figures on which these results are based are tabulated and the formulæ used are given. The bulk of these figures were obtained from an investigation carried out jointly at Newcastle upon-Tyne by the staff of the Coal Survey Laboratory of the Departent of Scientific and Industrial Research, and the staff of the Northern Coke Research Committee. A number—sixty-four—of repeat determinations for each test was carried out on one sample of coal or coke. Similar series of analyses on pure chemical substances were also carried out to determine to what extent, if at all, the discrepancies observed were due to a lack of uniformity in the samples of coal or coke. The report can be obtained from H.M. Stationery Office, price 9d.

It is well known, says *Nature*, that the windows of houses exposed to the sun's rays act like heat traps. They permit most of the radiant energy from the sun to pass into the building, but block the low-temperature radiation from inside surfaces passing out. Science Service has issued a report of results obtained by research physicists of the American Society of Heating and Ventilating Engineers in their laboratories. Formerly it was thought that glass absorbed only about 10 per cent. of radiation at low temperatures. The experiments show that a temperature of 550 deg. Fah. must be reached before any appreciable amount of the radiation passed through plate glass. Even at 1000 deg. Fah., only a small amount passes through. Glass obviously acts as a very efficient heat trap, and this has to be taken into account by the ventilating engineer. In many modern buildings, a side built almost entirely of glass is exposed to the sun's maximum radiation. On a hot summer day, the glass permits the heat from the sun to enter and practically none of it escapes. Indoors, therefore, it becomes unbearably hot. The cost of keeping a building of this nature cool is practically prohibitive. Awnings which deflect the light and are hung outside the windows are perhaps the most efficient. Shades and blinds are of little value as the heat passes through the glass, heats the blind, and is convected upwards, thus heating the room. Tests proved that there is no practical difference in efficiency between clear and coloured glass.

Miscellanea.

A pressure creosoting plant is to be put up at Prince Albert, Saskatchewan, at a cost of some 1,000,000 dollars.

The Nine Locks Ironworks, Brierley Hill, which have been idle for eight years, have been reopened with a good order book.

An aerodrome is to be made at Southend on an area of 157 acres, which has been acquired by the Council at a cost of £20,000.

The new ship of the Orient Steam Navigation Company, which is to be built by Vickers-Armstrong, will be slightly larger than the "Orontes."

The works of Ley's Malleable Castings Company, and Qualcast, Ltd., are to be considerably extended, and employment for another 1000 men thus provided.

It is proposed to construct a bridge across the First Narrows of Burrard Inlet, Vancouver, at a cost of about £1,200,000. The bridge will have a span of 1500ft.

The Tyne Improvement Commissioners are considering the question of fitting anti-coal-breakage appliances at No. 4 and No. 5 staithes at Whitehill Point, North Shields.

The Acklam Steel Mills of Dorman, Long and Co., which have been idle for three years, are being re-started. Two more blast-furnaces have also been relighted at the Cleveland Ironworks.

It is claimed that the 715 horse-power Wright Cyclone F engine used by Colonel Lindbergh in his recent flight is the lightest engine in the world. It is said to weigh 1·22 lb. per horse-power.

In November, the second section of the First State Ball-bearing Plant in Moscow was opened, thus completing the whole enterprise, which is, it is claimed, now the largest of its kind in the world.

Although the new bridge at Middlesbrough, which has cost £600.000, was opened to traffic on Wednesday. the 20th, it will not be formally opened, by the Duke and Duchess of York, until February 28th.

It was reported to the Tyne Commission at Newcastle that the coal and coke shipments for November were the largest monthly shipment for 2½ years, and that the total for this year of 11,791,521 tons was 215,000 up on last year.

Very rich copper deposits have been discovered in the Djez-Kargan region, in the Kazak Republic. The reserves are estimated at 2 million tons, and the copper content is so high as to make it the cheapest copper obtained in the Soviet Union.

A winch for the French trawler "Jutland," which, when she is launched at Frederikshavn, will be the largest of her kind afloat, is being supplied by James Robertson and Co., of Fleetwood. The winch weighs 23 tons and will deal with 1200 fathoms of steel cable.

Another instance of "ship surgery" is to be carried out by Messrs. Palmers, of Hebburn-on-Tyne, who have been awarded a contract to lengthen s.s. "Doric Star" (10,441 tons). This vessel is to have her present fore-end cut away and a new portion, 30ft. long, added. This will include a bow of the Maier form.

The demands at the electric power stations of Birmingham during the first week of December broke all records with a total load of 200,000 kW, as compared with a maximum of 177,000 kW last year. On one day during the month as much as 2,656,000 units were produced, an increase of 15½ per cent. over the corresponding record of last year.

A sum of 6 million roubles is to be spent by the Soviet Government for the erection of three factories for the production of chemical fertilisers. Two of the factories will be operated in connection with the Kuznetsk and Magnitogorsk iron and steel works, utilising waste coke-oven gas. The third factory is to be constructed in Chirchiky, near Tashkent.

According to figures published by the *Northern Miner* (Toronto), twenty-five new gold mills are now under construction by Canadian mining companies, the completion of which will add over 6000 tons daily to the industry's milling capacity. In Ontario, which had eighteen producing mines on June 30th last, twenty-eight or thirty mills are likely to be in operation next June.

The erection and equipment of a patent fuel plant at the Bulgarian State collieries at Pernik have, says the *Iron and Coal Trades Review*, been completed, and the first briquettes produced. Preliminary trials of the plant are reported to have been very satisfactory. The patent fuel made will be used by the Bulgarian State Railways, which will now become independent of foreign supplies.

According to *Flight*, the directorate of Aeronautics at the U.S. Department of Commerce has announced plans for the establishment of 2000 additional landing grounds in the United States; 10,000,000 dollars of the civil works funds have been set aside for this purpose. The main object is to extend the Federal Airways system to all parts of the country at present not served by airways, and thus to increase the safety of private flying.

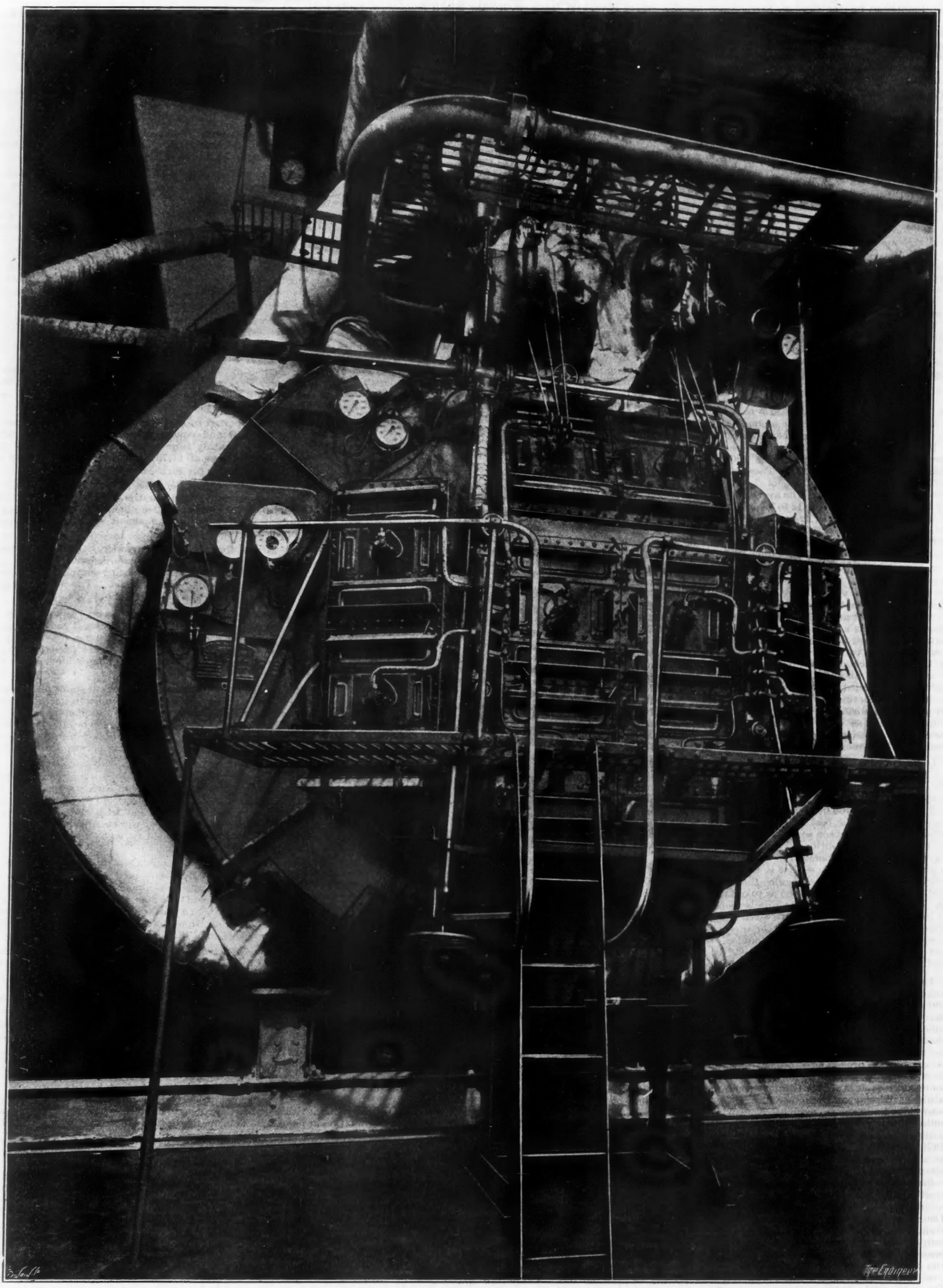
The recent change-over from D.C. to A.C. electric supply at St. James's Palace has necessitated some alteration of the Siemens' telephone system which has been in use there for some years. A rectifier has now been installed for "floating" the battery, and while the alterations were in progress it was decided to renew the battery also. Siemens Bros., Ltd., have, therefore, installed a set of six chloride cells of sealed-in Planté type.

Blyth, Northumberland, appears certain to eclipse all records in coal exports this year. The highest figure hitherto attained was in 1929, when 5,750,000 tons were shipped. At the end of the first week in November this year the total had reached over 4,760,000 tons, and weekly outputs in the neighbourhood of 150,000 tons were higher than ever before. The month of November witnessed the Blyth Harbour filled with vessels awaiting coal, with the result that the Harbour Commissioners are having to push ahead their extension schemes as fast as possible.

THE JOHNSON NAVAL TYPE BOILER

CLARKE, CHAPMAN AND CO., LTD., GATESHEAD-ON-TYNE, ENGINEERS

(For description see page 648.)



The Engineer

DECEMBER 29, 1933.

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

NOTICES TO READERS.

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The Metallurgist.

THE DECEMBER NUMBER OF
THE METALLURGICAL SUPPLEMENT TO
"THE ENGINEER" ACCOMPANIES THIS ISSUE.

Development of the Parsons Steam Turbine.

The steam turbine is one of the landmarks in engineering industry. Coming at a time when the electrical age was beginning, it both made large scale electricity supply possible and was made by it. The first turbo-generator made under Parsons' patent of 1884 developed about 7·5 kW; single turbo-generators over 100,000 kW capacity are now running. The present estimated value of Parsons turbines alone is £152,000,000, the figures for marine and land turbines being £92,000,000 and £60,000,000 respectively. Nothing to equal that rapid extension of value and dimensions has ever happened before.

Before the death of Sir Charles Parsons we had taken preliminary steps for the publication of a series of articles on the development of the Parsons turbine to celebrate its jubilee. The preparation of that series has been delayed by one cause and another, and can now not benefit by his personal supervision, but if it lacks anything of the vivid touch which he might have given, it still remains a most fascinating history. We need scarcely say that the publication of the series, which will begin on January 5th, 1934, will occupy many weeks, but the history is one in which every engineer takes a deep interest and pride, and we have no doubt that our articles will be widely read and appreciated.

CONCRETE FOR SPECIAL PURPOSES.

THERE has been in the past few years a noticeable increase in the attention given by engineers and research workers in all parts of the world to the problem of producing cement more suitable for certain special purposes than the ordinary standardised Portland cement. During the past decade the contributions to technical literature on the subject of specialised cements have been considerable. The matter has also been raised at several congresses and technical meetings, both of international and national or local character; for instance, the relative suitability of Portland and trass or Pozzuolanic cements for work in sea water was discussed at length by the International Navigation Congress at Venice in 1931. More recently interest has been focussed on the subject during the meeting of the International Commission on Large Dams in Sweden in July last, and in the course of the informal discussion at the Institution of Civil Engineers on November 15th on the desirability of introducing more than one standard for Portland cement and a standard for Pozzuolanic cement. On both of these occasions attention centered on the necessity of obtaining and using for large dams and other structures subject to unilateral water pressure a cement specially suitable for such works. Mention of some of these problems has also been made in the series of articles on the Scandinavian Congress and on Hydro-electric Power Plants in Sweden which have recently appeared in this journal. It seems therefore opportune briefly to review the situation.

Much more attention has hitherto been given to the problem abroad than in this country, and, although some important researches have been carried out in Great Britain on the behaviour of cements under special conditions, the quantity of cement for constructional purposes, other than normal Portland cement, at present used or produced in this country is relatively very small. Blast-furnace slag cement—known in this country as Portland-blastfurnace cement—is the only alternative to normal Portland cement at present covered by a British Standard Specification, and it is not produced in Great Britain on a large scale—relatively, at any rate, to the production of standard Portland cement. Valuable research work has, nevertheless, been carried out by the Building Research Board and by the Committee of the Institution of Civil Engineers on Deterioration of Structures in Sea Water. On the Continent generally Pozzuolanic and trass or quasi-trass cements are largely employed, not only for sea works but for other forms of construction and frequently as an addition to Portland cement. A cement of trass character, known as gaize, has in recent years been used with apparent success for harbour works in France. A new and comprehensive cement specification is proposed by the French standardising body, L'Association Française de Normalisation. An article in a recent issue of *Revue des Materiaux de Construction et de Travaux Publics* indicates that the draft of this specification covers a very full range of hydraulic cements embracing nine different groups or types, and no less than thirty-six grades. The production of a suitable cement for large masses of concrete is one of the most important problems to be solved at present in connection with the construction of large dams. Normal Portland cement as now produced in this country possesses certain characteristics which render it not ideally suitable for dam construction. The efforts of manufacturers and chemists hitherto seem to have been directed in the main to the increase of the strength of the cement and concrete in the initial and early states and to the perfection of methods of fine grinding. The considerable heat rise of modern fine ground cement in setting and hardening is often a source of trouble when large monolithic masses of concrete are formed in a dam structure. Furthermore, the partial solubility of normal cement in water, particularly in acid waters, is sometimes a cause of rapid deterioration in concrete structures exposed to water pressure and percolation. American chemists and engineers have met with considerable success in the production of low-heat cement for use in the construction of the Hoover and Pine Canyon dams in the United States, but, as the content of free lime in the American special cement is greater than in normal Portland cement, it is possible that the solubility in water of the former may even be greater than that of ordinary Portland cement, and, so far as we are aware, the specification for the cement used on these works does not embody any stipulations concerning its solubility. The *Engineering News-Record*, commenting a few weeks ago on the proposed French cement specification, mentions the dissatisfaction of many American engineers with the present single-standard specification. "Consideration of this wide range of hydraulic cementing materials," observes the editor referring to the specification, "tends to support the growing belief that a particular cement is not necessarily best adapted to different service conditions, and that proper conservatism need not interfere with new developments in materials." We understand that experimental work on the production on a commercial scale of a low-heat cement is now being carried out by cement manufacturers in this country. As far as we are aware, however, this product is not likely to have a greater resistance to the action of water than normal Portland cement, and in this respect the limited scope of these researches is to be regretted. Attention has, however, been specially directed in the past few years to this matter of solubility by engineers and chemists in Scandinavia, where the water held up by dam structures is usually of an acid character. The cement manufacturing industry in Sweden has carried out an important series of researches to investigate the possibility of producing commercially a cement specially suitable for structures subjected to the unilateral pressure of water, and, in particular, water of an acid character, which at the same time should generate as little heat as possible during setting and hardening. These investigations were made at the request of civil engineers in Sweden engaged on dam construction, and they have been so far successful that, early in 1932, a cement, richer in silicate than ordinary Portland cement, and known as silicate cement, was placed on the market. It is now being used in Scandinavia in the construction of dams, including the barrage and other works of the Vargon hydro-electric power station which we described recently. In Norway one of the dams visited by members of the International Congress on Large Dams in July last—that at Gronvollfoss on the Tinne River—has been built with a special cement, having a low content of lime and therefore relatively low solubility in water, which was manufactured in a special plant erected near the site of the work.

At the meeting of the International Commission on Large Dams at Trollhattan in July last, it was resolved that a report on cements most suitable for use in the construction of dams should be prepared for presentation at the next meeting of the Commission. Following on this resolution it has been proposed to form a special international committee to consider the subject in detail and to collate the results of experiment and research now being carried out by cement manufacturers, engineers, and chemists in all parts of the world. It is suggested that the various national committees of the Commission should be asked to arrange for further research work in their respective countries, and in due course to communicate the results to the International Committee in Paris. In the course of about two years it may be possible, if this procedure is carried out, to reach some authoritative and valuable conclusion on the subject. It is satisfactory to know that something is being done in this country, even if only on a limited scale, to meet the needs which we have indicated thus briefly, but it seems to us that more is required if British industry is to retain the high position it now holds in the production of high-class cements. There is little doubt that the demand for one or more additional forms of cement for special purposes is sufficiently great to justify production on a commercial scale by cement manufacturers.

Ill-Informed Railway Criticism.

WE have more than once had occasion to express regret that so many members of the general public rely upon the popular Press for their opinions on specialised questions of the day. That tendency is particularly unfortunate when the subject is one on which the papers themselves, because of their lack of the necessary inner knowledge of the facts, form their conclusions from superficial appearances. In no direction is this more manifest than in relation to railways, concerning which there has been an agitation recently for larger wagons and for the fitting of vacuum brakes to all freight trains. Actually, the demand for the bigger wagon was begun, in the journal now in our mind, a couple of years or more ago, when there was an agitation for a wagon of 40 tons capacity! That was based on the experience of the writer of those articles on South American railways. Conditions there, and in the United States and Canada, are altogether different from those in Great Britain; moreover, the railways of Germany, France, Italy, and other Continental countries use, like the British railways, the smaller wagon. The railways of North and South America call for long hauls of consignments in bulk. British railways, on the other hand, have to cater only for comparatively short journeys, and such bulk consignments as are common in America are very exceptional here. A good deal of the freight business done by British railways is in small lots. The American railways do not touch these as individual consignments; they are handled by the Express companies, which collect, transport in their own trucks, and deliver them, and the only duty of the railway companies is to convey the Express companies' trucks. The competition of the road transport interests makes the need for the big wagon for general merchandise less than it was. The railway companies dare not wait until there is sufficient traffic on hand to fill a wagon. Hence, in order to retain the traffic, wagons are dispatched not fully loaded. In this relation we are, of course, discussing general merchandise, and not the transit of mineral traffic; for the latter, a 20-ton wagon is now the universal standard. For merchandise the standard wagon is one of 12 tons capacity, and although our daily contemporary made a sarcastic reference to the London, Midland and Scottish having ordered 2000 wagons of only 12 tons capacity, that seems sound policy when the Railway Returns show that the average load for a wagon containing general merchandise is less than 3 tons.

Continuous brakes for freight trains are less universal than the big wagon. Their introduction on to the railways of North America came almost naturally, as that country originated continuous brakes for passenger trains. But such equipment on freight trains was more necessary there than in this country. Owing to the more generous dimensions of the American structure gauge, the locomotives there were bigger and more powerful than those in this country, and they were capable of hauling much bigger loads and longer trains than were employed here. Thus a need for continuous brakes arose. The greater length of the American train was a serious matter for the railway companies, as it necessitated a large number of brakesmen to accompany each train in order to apply the hand brakes on individual vehicles as required. It is to the credit of British railway companies that they saw one serious objection to the adoption of continuous brakes on freight trains. That was the greater danger that would attend the occupations of the shunter and the goods guard, since they would have to pass between the buffers of adjoining wagons in order to couple and uncouple the brake pipes. As the American railways have automatic couplings, there should be no necessity for men to go between the wagons to couple and uncouple, but in such a normal year as 1927 forty-eight men were killed and 1325 injured when engaged in coupling movements, and twenty-one were killed and 398 injured in coupling or uncoupling the brake pipes. In this country, although automatic couplings are the exception, there were in that year only four killed and 418 injured. But when the newspapers urge British railways to equip their freight wagons with continuous brakes they are preaching to the converted. That has been the policy for a good dozen years, and, from time to time, our pages have recorded how the companies have provided so many wagons equipped with the vacuum brake, and the number of freight trains of the two classes—No. 1 freight with a large proportion of the wagons braked and No. 2 with a lesser proportion. Trains wholly or partly fitted with the vacuum brake have two particular merits; they can travel at a high overall speed, seeing that they can postpone deceleration on approaching a stopping point longer than can a non-braked train, and they can travel with greater safety because of a more ready stop in the event of danger, and because they will automatically be pulled up should a coupling fail. The greater use of braked trains to-day is to allow for the just-mentioned greater overall speed, so as to help towards quicker journeys for consignments, and thereby to meet road competition. Especially is this advisable where long distances are concerned, as therein the manufacturer and trader must be shown that the railway can deliver as readily and as speedily as can road transport from door to door.

Criticism of the railways is common because everyone uses the railways and because it is so easy to make. No one seems to think that it is necessary to be an expert in railway matters. People who have never heard of traffic density will abuse our companies for not running more trains, and who have never looked at a loading or a structure gauge will ask why they do not see on our lines locomotives as big as those found in America. They speak, too, as if British railways were inert and unprogressive; yet if they would throw their minds back a score of years, even a decade, they would be able to identify a dozen directions in which obvious progress had been made, and they, of course, would miss all the unseen improvements which the companies have carried out. In one sense the railways have brought the trouble on themselves. Not until within the last few years did they take any pains to let people know what they were doing. They, so to speak, threw Bradshaw at the head of the public, told it to select its train, and leave the rest to them. Now they are paying a great deal of attention to publicity—witness, for example, the triumphant march of the "Royal Scot"—and, as years go by, we may hope—not very hopefully—that the public will know so much about railways that ill-informed criticism will no longer be heard.

Shipbuilding.

The end of 1933 finds us with about 20,000 more men employed in British shipyards than at the moment of deepest depression in 1932; but we shall still have about 50 per cent. of our recognised (insured) shipyard workers unemployed. This deplorable percentage is worse than it looks, for since 1920 the number of men attached to the industry has been reduced by one-half. In other words, four times as many men were at work in 1920 (and in 1913) as there are at this moment. However, the present movement is definitely upward, and promises to be progressive over a long period. We are on the way back to prosperity, though we may never employ quite so many men in shipbuilding as in past years.

In November British shipbuilders secured orders for more than 100,000 tons of new merchant shipping, plus some notable contracts from the Admiralty, and many more orders are expected in both lines. The Clyde, Belfast, and the Tyne together booked more merchant work in the six weeks ended November, 1933, than in the whole twelve months of 1932—and far more naval work too—and it seems probable that 20 per cent. of the building berths will be occupied at the beginning of the New Year, compared with only 5 per cent. fifteen months ago. Still more work is in prospect. Old ship "scrapping" is proceeding at four times the rate it attained in 1932, and the price of scrap is a good deal higher. Much of the money obtained from the shipbreakers will be spent on the new economy ships our builders offer, for owners realise that if they are to remain in business they must have modern ships. Our metallurgists have so improved steel, our engineers have so improved engines, boilers, and auxiliaries, and our shipbuilders have so improved their productive methods and the make and shape and adaptability of ships, that the forty, thirty, twenty, and even in some cases the ten-year old vessel is no longer economical to operate. In fuel consumption alone, per ton of cargo capacity and per knot of speed, the new ships are far more economical than the old vessels. We expect to see old ship "scrapping" on a huge scale, and new ship construction on a large scale. Among other factors there is a movement to reserve coastal and inter-Empire trade for British shipping, as foreign nations reserve their trade for their own ships, and for equalising in other ways the competition between foreign protected and subsidised shipping and our own shipping. Foreign subsidised shipping has eaten seriously into our commerce, but opposition to it augments daily, and we may soon see the percentage of British imports and exports carried in British bottoms increased.

Fortunately, the ability of our shipbuilding industry to meet competition within its own scope stands high. There are no shipyards in the world better equipped or laid out than British yards. Any little decline we suffered a few years ago by comparison with new yards abroad has been made fully good. There are no overseas yards nearly so well placed as our yards are in the matter of supplies of material. Our yards are close by coal mines and steel works. A ton of shipbuilding steel, like a ton of fuel required for a shipyard, carries the lowest transport costs in the world. The transport charges on shipbuilding materials in America, Germany, Holland, and the other competitive countries range from three up to nearly twenty times as much as in Great Britain. We actually have mines, ironworks, and shipyards next door to one another in this country. And we have workmen and engineers with an ingrained—almost an inborn—capacity and skill for ship construction. Given a continuation of industrial peace, and our resources and abilities justify a hope in the resuscitation of shipbuilding before many months have passed.

Literature.

Moscow, 1911–33: *Being the Memoirs of Allan Monkhouse.* London: Victor Gollancz, Ltd. 1933. Price 16s. net.

We need not remind our readers that Mr. Allan Monkhouse is one of those Metro-Vick engineers whose arrest by the Soviet Republic last March caused an international sensation. Reading his memoirs one is more than ever astonished by that event, for by every word he uses Mr. Monkhouse shows himself sympathetic to Russia, the Russian people, and Russian ideals. There is a not unnatural tendency to think, "here is a man who has lived in Russia for many years, who has been expelled from it in disgrace, and is anxious to curry favour so that he may again be taken into favour." No human emotions are single and simple, but we are convinced that Mr. Monkhouse has written from affection and that ulterior motives have weighed little, if at all, with him.

It is a readable book, written in an easy and pleasant style, and covers a long period and a large area. But, as brother engineers with those who suffered the indignity of imprisonment, we turn at once to a chapter entitled "The Moscow Arrests, March 11th, 1933." It opens with these words, of whose significance the meaning later becomes clear: "In January, 1933, it was evident to a great majority of the population of the U.S.S.R. that the first Five-Year Plan had not completely fulfilled expectations." Stalin, on January 7th, 1933, had explained the failure by asserting that opponents "are doing as much mischief as they can, working silently underground. They set fire to warehouses and break machines. They organise sabotage," and so forth. But there were sceptics, and a counter-revolutionary plot had to be "revealed." Accordingly, on March 11th—the day of the arrests—the O.G.P.U. announced the discovery of widespread counter-revolutionary activities. But the trouble began several weeks earlier, when Miss Kutosova, Mr. Monkhouse's private secretary, was suddenly arrested in his office and dragged off by the O.G.P.U. She returned next day a broken woman, with ink-stained fingers, silent on what had happened to her, but evidently forced "under threat of serious consequences to herself and probably to her relatives, to act as an agent of the O.G.P.U." That was on January 25th. Two days later Mr. Monkhouse's suspicions were aroused by other events, and on February 6th, 1933, he came to London. Here he was assured, in the presence of his own Chairman, by Mr. Ozerski, the Soviet Trade Representative in London, that the O.G.P.U. had nothing against the company and nothing against him personally. Acting on that assurance he returned to Moscow on March 7th. Then, four days later, "We had finished dinner, and were seated in the lounge, when suddenly a door was thrown open, and, almost before we could realise that anything unusual was occurring, eight stalwart O.G.P.U. officers and N.C.O.'s were in the room. They were led by a dark young officer of short stature, who, it afterwards transpired, was actually one of the highest officials in the much-dreaded organisation." There followed a search "as thorough as imagination could make it," but rendered grimly ludicrous by the sinister meaning attached to correspondence with the British income tax authorities, and the difficulty of explaining away a small boy's drawing of a "puffer"! In the first hour of the morning the search was complete and Mr. Monkhouse was taken to the Lubianka Headquarters. The rest of the story would take too long to tell, but it is related with dramatic effect. It came as suddenly to an end as it had begun. Two days later the prisoner was released on the condition that he did not attempt to leave Moscow.

The following chapter is devoted to the Moscow Trial. In view of the opinions held by some, and of Mr. Monkhouse's long knowledge of and real sympathy with Russia, his own concluding words must be quoted: "It only remains to be said that the Soviet Government has allowed its responsible agents—the Economic Department of the O.G.P.U., the Public Prosecutor of the R.S.F.S.R., and, finally, Judge Ulrich, of the Supreme Court of the U.S.S.R.—to organise and stage a trial which has been correctly described as a travesty of justice, and which has, without doubt, discredited their Government and their country in the eyes of the civilised world." No contention that the author, as one of the victims and as the intimate friend of others, was biassed and incapable of fair judgment can weaken the force of his assertion, for, as we have said, his sympathies are with Russia, and he is no doubt familiar with the ordinary course of the justice in that land. "As one who has made it his duty," he writes, "to understand the aims, ideals, and objects of the Soviet Government, and has done his utmost to interpret this knowledge of the U.S.S.R. to promote a better understanding between Great Britain and that country, and, moreover, has done everything he reasonably could be expected to do to assist in the fulfilment of the vast plans of the State Planning Department, it is, indeed, a bitter disappointment to see the Soviet Government become a prey to fanaticism and class hatred to such an extent as to allow itself to be led into a blunder of this kind." How great that blunder was will perhaps never be known, or never be revealed, for the mouths of those who could speak of things which Mr. Monkhouse has withheld are sealed.

We have devoted what space we could spare to the most dramatic part of our author's narrative, but we should leave a wrong impression of his memoirs if we let it be believed that they are all tempered and affected by the episodes of last spring. The shadow of those events does not lie over the major portion of the work, in which will be found an interesting account of Russia and her people, with comments upon her efforts to erect an industrial organisation of vast magnitude, and to establish a new constitution.

The Motion of Railway Vehicles on a Curved Line. By C. F. Dendy Marshall, M.A., M. Inst. Loco. E. London: *The Railway Engineer*. 1932. Price 12s. net.

This interesting paper shared jointly with another the George Stephenson Research Prize awarded by the Council of the Institution of Mechanical Engineers in 1930. It was published in various instalments in our contemporary *The Railway Engineer*, in 1930 and 1931, the corresponding pages being subsequently bound together in book form.

Apart from a concise preliminary history of the practical solution of the problem by means of the bogie, pony truck, and radial axle, and suggestions, towards the end, regarding possible improvements in bogies, the paper describes a mathematical investigation of the motion of vehicles on curves, and of the positions taken up by the wheels of a 4-6-0 engine on curves of various radii.

The motion of vehicles on curves is considered in Chapters II. and V. The author assumes that, in theory, friction should be sufficient to resist the centrifugal force, disregarding in this connection the effect of the coning of the tires. A wheel with a coned tire, if rolling freely, would describe a circle about the apex of the cone of which the tire forms a part, and this apex is situated from 30ft. to 70ft. outside the wheel, the actual distance being ten times the diameter of the wheel. Two such wheels mounted on a common axle are constrained, by the resistance of the axle to elongation, to move along parallel lines, and both wheels are subjected either to a constant side slip, or, more probably, to a series of side slips. Even on straight track it cannot be assumed that equal side slip always occurs on each wheel, and it is only the flanges which ensure equality of the sum total of the side slip on each wheel. On curved track, with either a preponderant centrifugal force or superelevation, it is reasonable to suppose that the wheels would move outwards or inwards with extreme sensitiveness, and the behaviour of railway rolling stock confirms this.

The tension produced in the axle must be sufficient to overcome the friction between wheels and rails, and, with continuous side slip occurring, the rails would be thrust inwards. More probably the rails alternately bend inwards as much as play and elasticity will allow, and then spring back when the resistance is sufficient to overcome the friction, and side slip occurs. In the case of flat-bottomed rails spiked down to the sleepers, it is always the outside spikes which are most worn, even on straight track, indicating that, in actual practice, the rails are subjected to lateral pressure from the flanges of the wheels, exceeding, in its effect, that required to overcome the friction between wheels and rails, and extremely difficult to investigate mathematically.

The comprehensive investigation of the position taken up by the wheels of a 4-6-0 engine on curves of various radii, which forms the subject of Chapter IV., is somewhat difficult to follow, and illustrations drawn to distorted scales would have been helpful, especially as there is very little explanatory text. The calculations depend on perfect track alignment and uniformity of gauge, and such small differences in flange play as $\frac{1}{32}$in.

Bearing in mind the unequal wear of flanges, and the difficulty of maintaining such perfection in the track, it is not surprising that the paper provoked discussion as to the practicability of mathematically investigating the complex movements of railway rolling stock. Such criticism does not detract from the valuable investigation so ably carried out by the author, and is, indeed, necessary as a reminder that in making use of the results, due regard must be given to the assumptions on which they are based.

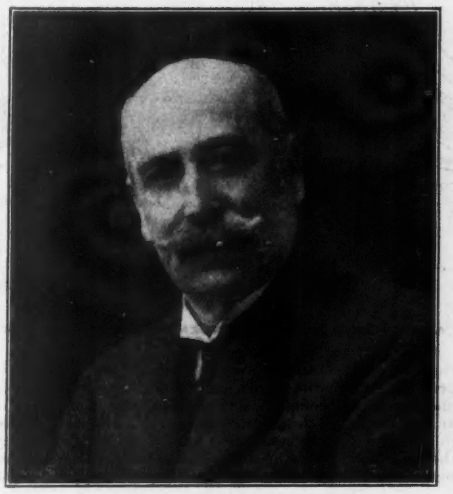
Two formulæ are compared, determining the radii for radial axle-boxes and pony trucks, and attention is drawn to the different results obtained, but as, in the first method, an approximation is used on one side of the equation and an exact value on the other, a precise result cannot be expected.

The Pullman cars that run on various trains of the London, Midland and Scottish Railway in Scotland were, as from December 1st, transferred, with the staff of attendants, from the Pullman Car Company to the L.M.S. Company.

Obituary.

Mr. G. J. CHURCHWARD.

We regret to have to record the sudden death of Mr. G. J. Churchward, until the day of his retirement one of the outstanding personalities of the railway world. His death occurred on Tuesday, December 19th, when, walking outside the grounds of his house on the tracks of the railway company he served so well, he was struck and instantly killed by the "down" Fishguard express at about 10.30 a.m. No one was by to watch his end. Perhaps—who knows?—the man who had devoted his life to the railway would have preferred, had the choice lain in his own hands, just such a quick death as this rather than a long, lingering decline, and a slow failure of all the once alert and active faculties. But to his family and his friends, of which there were many, the shock coming at so unseasonable a time of year was severe. By his own wish he has been buried in the yard of the parish church overlooking on one side the works of which he once had control, and on the other the rolling Wiltshire downs he loved so well.



MR. G. J. CHURCHWARD

From the very first Mr. Churchward's engineering life was connected with railways. Having been born at Stoke Gabriel, in the county of Devon, he started his career as an articled pupil with the South Devon Railway, and when that company was amalgamated with the Great Western in 1876 he was transferred to Swindon. Six years later, with considerable experience in the drawing office behind him, he was appointed assistant manager in the carriage works. Here, in collaboration with Mr. Joseph Armstrong, Junr., he proved of what mettle he was made by perfecting the vacuum brake. Later, directing his attention to the lubrication of carriage stock, he developed a system of resilient pads and oil boxes which has been found so satisfactory and efficient that it is almost universally used to this day. The change of gauge gave him the opportunity to demonstrate his powers as an organiser in distinction to his abilities as a designer, and the novel and efficient arrangements he made in conjunction with Mr. Dean for anticipating the requirements consequent upon the change so far as coaching stock was concerned, are still remembered. During his time many improvements were made in rolling stock. He was concerned in the development of gas and later of electric lighting for coaches, and in the fitting of the vacuum brake to goods stock, to mention but a few of his activities.

But, unquestionably, Mr. Churchward will be best remembered in connection with locomotives. He early realised the value of standardisation, and with this object in view directed his attention to locomotives, and particularly locomotive boilers. No one, least of all the Great Western Railway, is likely to forget his services in this direction, for the four-cylinder, six-coupled engines he designed placed the company in the forefront of locomotive practice in Great Britain. His most celebrated engine, which conformed with the standards he had adopted, was "The Great Bear."

In 1902, on the retirement of Mr. William Dean, the post of chief mechanical engineer was given to Mr. Churchward, who held it with great distinction for nineteen years until his retirement at the end of 1921. During this period the steady march of progress under his direction raised steam pressures from 180 lb. to 225 lb. per square inch, and brought into use the superheater.

Although, to the laymen, Mr. Churchward's name is indissolubly connected with improvements in locomotives, by railwaymen the value of his work in organising maintenance work is fully realised. With the advice and help of subordinates he designed the standard Great Western (1-2-3-4) unit engine shed, of which many have been erected since 1902, and it was during his time as chief mechanical engineer that the value of water softening was realised. Eight plants were brought into use.

But it is not only in his railway work that the effects of Mr. Churchward's beneficent personality are to be traced. His death is a great loss to the inhabitants of Swindon, who had looked to him during many years for support and guidance. In his public capacity he gave his services generously. As early as 1897 he became Chairman of the new Swindon Urban District Council, and he was for many years a member of the Water Board. In the sphere of technical education, in which he took great interest, his zeal and foresight are still remembered by many men now filling posts of authority throughout the world. A few months before his retirement Mr. Churchward was presented with the honorary freedom of the borough. Another honour which he always regarded as a collective acknowledgement of the excellent work performed by the employees at Swindon during the Great War, was his creation as a Commander of the Order of the British Empire.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STEEL TRADE REORGANISATION.

Sir,—You publish in your issue of December 10th a leading article on "The Steel Trade Reorganisation Plans." It is good to see these proposals given wide publicity, as a scheme such as is laid out by the National Committee is so radical a departure from the system which has formerly enabled this country to lead the world in the steel industry that everyone, even remotely concerned, should give it serious study.

Being intimately connected with one branch of the industry, one may not see all the difficulties of the many other interests equally important and nearly connected. It would appear, however, that the National Committee have been unable to free their minds of a pseudo-socialistic scheme for the industry and wish to eliminate all individualism. This is exceedingly regrettable and, I submit, will never bring progress or prosperity to the British steel trade.

In considering defects in any business one should look to the head, and if faults occur at the top they will surely continue and grow throughout the whole organisation; whereas if there be no failings there, any other troubles will not be very difficult to overcome. Following this procedure, one must consider the case of the actual producers of pig iron and steel in this country, and be sure that if this basic part of the industry were put in order other troubles connected with branches depending on these productions will be remedied naturally and quickly.

There exists at present an association, one of the functions of which has been to fix prices for sale to other manufacturing branches of the trade. These prices have been fixed at levels which allow such a margin of profit that inefficient and out-of-date works can continue to produce and other works seek for ways and means to circumvent their own agreements and in effect sell at a lower price by undertaking part of the work which should be executed by their customers and doing the same at a loss. With such examples of "associations" still continuing to function in this way, surely no other part of the industry will wish to extend the "association" idea.

The basic fact is that the output of the present steel plants of this country cannot be absorbed at the present prices and in the absence of a substantial export trade.

It should be recognised that only the most efficient plants can ultimately exist, and the natural way to attain this object would be to immediately cancel all fixed prices, when a period of healthy and uncontrolled competition would naturally eliminate the obsolete works. Such an action would be quickly followed by similar results in all other branches of the industry and rapidly enable a sound and healthy steel trade to again be built up by individual firms who are anxious to make progress in fair competition with all others.

The legitimate functions of an association could still be exercised in the way of a levy on home trade to assist extension of export business which is eminently necessary to this country or in other internal matters of the industry. No association should be allowed to act in such a way as to prejudice the whole of the industry dependent on its products as the present Steel Association does. Given this freedom and continued support from the Government in the way of import duties to prevent dumping of foreign manufactured products, there is no reason why the industry should not again regain prosperity.

It is unthinkable that the individual firms of this country will submit to control which you rightly term "bureaucratic in inception and construction," and which is utterly alien to the British character and temperament.

Stanley G. Newstead.

London, December 19th.

An interesting example of the use of wireless in industry is the regular communication service maintained by the Consolidated Diamond Mines of South-West Africa, Ltd., between their station at Luderitzbucht (South-West Africa) and their mining camp at Oranjemund, 160 miles distant. The apparatus at each end is worked by a $1\frac{1}{2}$-kW paraffin engine generator set.

The Johnson Naval Type Boiler.

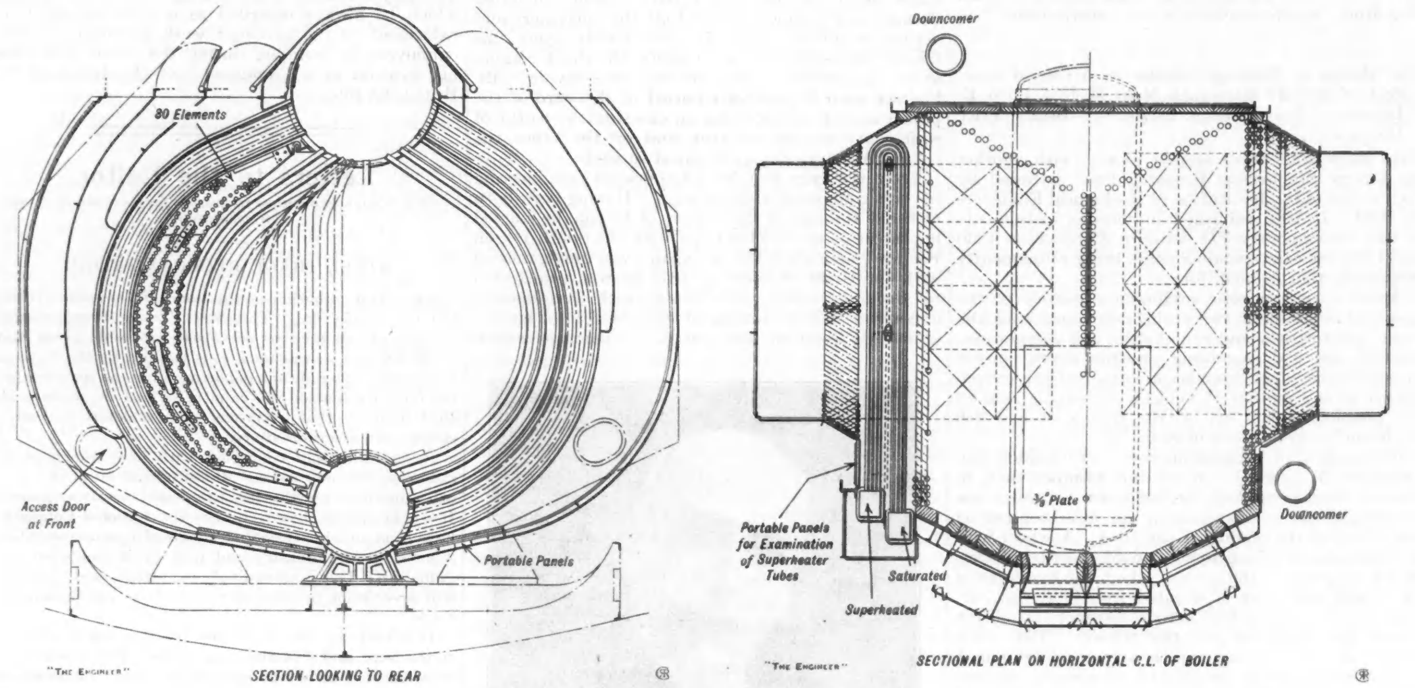
Successful tests have recently been completed at the works of John Samuel White and Co., Ltd., East Cowes, on a "Johnson" marine type water-tube boiler, manufactured by Clarke, Chapman and Co., Ltd., of Gateshead-on-Tyne, for demonstration to the Admiralty. We recently attended full-power and overload trials of this boiler, of which a description is herewith given.

The Gateshead firm, it will be recalled, now holds the British and foreign rights to manufacture and to grant sublicences for the manufacture of this boiler. The first unit of this type incorporating an air heater and superheater was built by John Brown and Co., Ltd., at Clydebank, successful tests being completed in January, 1929. The maximum rate of steam generation was 13 lb. per square foot of heating surface. It was subsequently installed in the Canadian Pacific liner the "Empress of Britain," as one of a battery of nine main boilers, and has been in regular use ever since that ship was commissioned in May, 1931, working at a rating of 10 lb. per square foot of heating surface, or double that of another type of boiler in the same installation.

A smaller boiler, having an air heater, but no superheater, was built by another firm in 1930, and installed in the Canadian Pacific Railway Company's steamer "Princess Helene," in conjunction with two boilers of a well-known design. Prior to the official trials, the "Johnson" boiler was tested up to a rating of 12 lb. per square foot of heating surface, corresponding to 14·7 lb. from and at 212 deg. Fah. It was utilised in conjunction with the other two main boilers throughout the official speed and power trials, on the completion of which the vessel steamed from Greenock to St. John, N.B., at a speed of 14 knots with only the "Johnson" boiler in use for propulsion.

The "Johnson" boilers fitted in these two ships were the outcome of efforts on the part of the designer to produce a water-tube boiler suitable for merchant vessels, and capable of being worked continuously at a rating of at least 10 lb., with high efficiency. The results obtained in the two vessels mentioned have been so satisfactory that, after due investigation by the builders' and owners' representatives, it was decided to adopt this type of boiler for the Royal Mail liners "Asturias" and "Alcantara," in which the space available is unusually restricted for the power required. These boilers are now in an advanced state of construction.

The British Admiralty having exhibited interest in the potentialities of the boiler for naval purposes, a design was prepared and a unit duly constructed for demonstration by Clarke, Chapman and Co., Ltd. The results of the tests on this boiler constitute a notable technical achievement in the sphere of naval boiler performance. The essential data are given below, permission for publication having been granted by Vice-Admiral Brown, Engineer-in-Chief of the Fleet. The boiler, which we illustrate on page 644 and in Figs 1 and 2, has a generating surface of 9020 square feet and superheater surface of 1810 square feet, and was designed for a continuous evaporation of 165,000 lb. per hour. This output was, in fact, maintained during a special test for a period of twenty-four hours. The specified air pressure corresponding to this output was 4in., but with all ten burners on, it was actually 3·8in. An overload test of four hours' duration at a mean evaporation of 192,000 lb. was conducted later, and subsequent examination of the fire tubes and refractory revealed no signs of distress or damage. In both these tests exceedingly good combustion was obtained with standard Admiralty burners. The boiler was not provided with an air heater :



SECTION LOOKING TO REAR

SECTIONAL PLAN ON HORIZONTAL C.L. OF BOILER

Figs. 1 and 2—Sectional Arrangements of Johnson Boiler

Naval Boiler : Result of Tests.

	Designed load.	Overload.
Actual evaporation	166,320 lb./hour	192,122 lb./hour
Equivalent evaporation (from and at 212 deg. Fah.)	203,500 lb./hour	236,000 lb./hour
Steam pressure	300 lb. sq. in.	300 lb. sq. in.
Steam temperature	627 deg. Fah.	637 deg. Fah.
Feed temperature	183 deg. Fah.	183 deg. Fah.
Total fuel burned	14,069 lb./hour	17,140 lb./hour
CO_2	13·4 per cent.	13·44 per cent.
Funnel temperature	797 deg. Fah.	880 deg. Fah.
Air pressure at fronts	3·8in. W.G.	5·62in. W.G.
Lb. of fuel per burner.. ..	1,407 lb./hour	1,714 lb./hour
Ratios ;		
Evaporation per sq. ft. of generating surface :		
Actual	18·45 lb.	21·3 lb.
From and at 212 deg. Fah.	22·55 lb.	26·2 lb.
Evaporation per unit of boiler weight	1·3	1·5
Fuel burned per sq. ft. of generating surface ..	1·56 lb.	1·9 lb.
Fuel burned per sq. ft. of total heating surface ..	1·3 lb.	1·58 lb.
Fuel burned per cu. ft. of combustion chamber, volume	15·55 lb.	19·0 lb.

In Fig. 3 we illustrate graphically the results obtained over a wide range of loads. The points of interest in these curves are the variations in superheat, and the relationship between the boiler efficiency and the rate of oil burning. In this connection it may be stated that the radiation and unaccounted—for losses were of the order of 3 to 4 per cent., so that there is every reason to anticipate that the efficiencies which would be registered in an actual, relatively air-tight stokehold would be somewhat higher than those recorded in the present tests.

At the high rates of forcing during the foregoing tests, the furnace temperature, which is always difficult to determine with accuracy, was somewhat less than occurs in furnaces having a large area of refractory, and there was a notable absence of priming, whilst the superheat temperature was steady throughout. At fractional loads, it was found possible by adjustment of the dampers to obtain a considerable increase in the degree of superheat. It was demonstrated that no difficulty need be apprehended in the removal and replacement of fire tubes, it being possible to insert them through the furnace openings and place them in position, the flexibility of the tubes simplifying the operation.

The weight of this boiler with hot water is slightly under 57 tons, so that an evaporation of 86 tons per hour corresponds to an output weight ratio of 1·5. With the experience gained as a result of these tests and various experiments made, the designers anticipate that it will be possible to make refinements in design which will

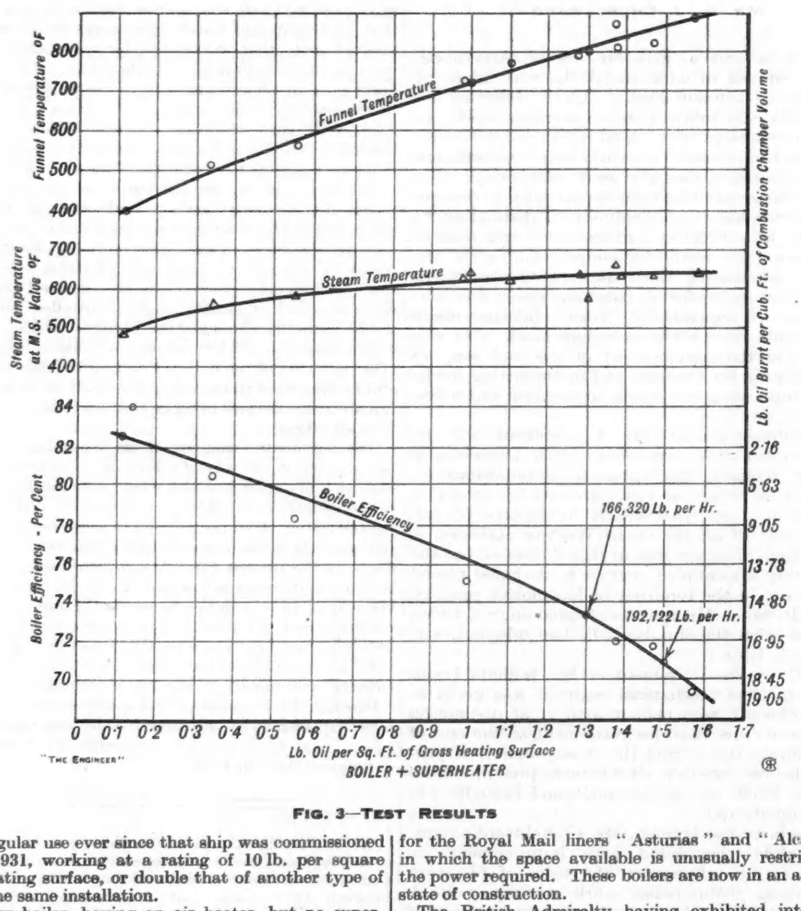


Fig. 3—Test Results

secure an improvement in this ratio. It is interesting to note that the total weight of brickwork in this boiler does not exceed 3·5 tons.

A feature of the test arrangements was the very complete equipment for maintaining the boiler feed and oil fuel supply, and dealing in two large condensers with the large volume of steam generated.

The tests were conducted under conditions arranged to approximate as closely as possible to those obtaining at sea. The boiler was housed in a corrugated iron building in which the atmosphere was kept at 5·63in. W.G. above atmospheric pressure. The air for combustion was not preheated. The feed water was in continuous circulation; after being pumped into the boiler and evaporated it was discharged into the surface condensers and thence to the feed tanks and feed pump suction. The auxiliary plant was as follows:—Two Weir air pumps; two condensers, provided by J. S. White and Co., Ltd.; four fans; two Weir fuel pumps; two turbo feed pumps; one feed heater. The steam was taken from the boiler to a de-superheater, which, in turn, exhausted into the two condensers. The two air pumps then discharged the condensate into calibrated tanks to which the feed pump suction was coupled.

The fuel oil and water were taken from special calibrated tanks which had been tested by the Admiralty. The tests were carried out using instruments approved by the Admiralty, which included a "Mono" gas analyser, a Cambridge multiple temperature indicator, and Budenberg pressure recorders.

Parallel Operation of Single Stage Boiler Feed Pumps.*

By Lieut.-Commander H. J. REDFIELD, U.S.N.

SEVERAL articles appearing in this publication have indicated the numerous advantages of the high-speed, single-stage centrifugal boiler feed pump for naval use. Pumps of this type were specified and obtained for heavy cruisers 24 to 31 having a head-capacity characteristic which was practically flat from the rated capacity (750 gallons per minute) to shut off. Actually, these units showed a slight droop at shut off or zero capacity (see Fig. 2, curve X).

The original idea in using flat characteristic pumps, proposed that by a flat characteristic no pressure-regulating governor would be necessary, since the pump would maintain a constant head at constant speed regardless of the capacity. This idea is perfectly sound, and pumps having a flat characteristic actually demonstrated that no pressure-regulating governors are required where paralleling is not necessary.

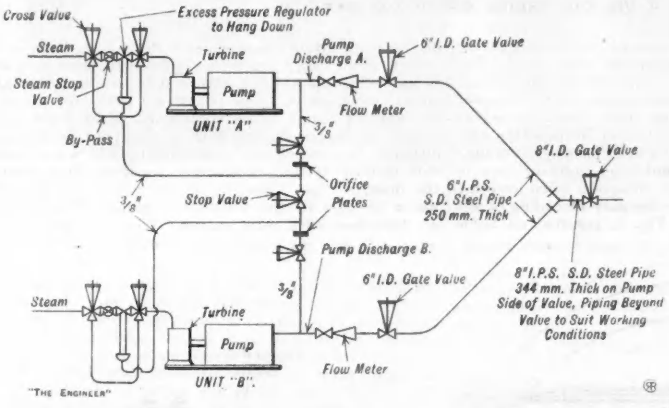


FIG. 1—PARALLELING OF PUMPS WITH SEPARATE PRESSURE GOVERNORS

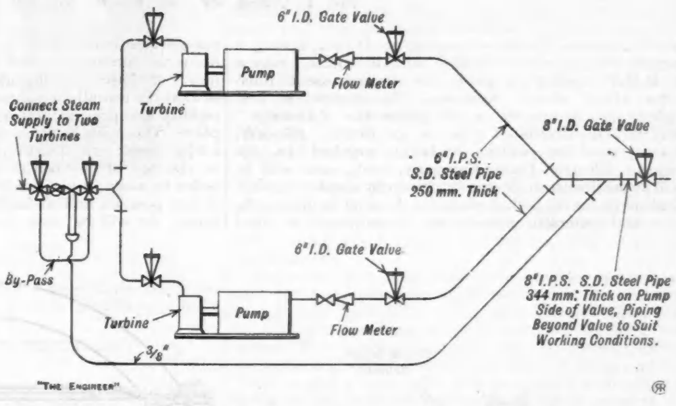

6" I.D. Gate Valve
Pump
Flow Meter
Turbine
Connect Steam Supply to Two Turbines
8" I.D. Gate Valve
6" I.P.S. S.D. Steel Pipe 250 mm. Thick
By-Pass
6" I.D. Gate Valve
Turbine
Pump
Flow Meter
3/8"
8" I.P.S. S.D. Steel Pipe 344 mm. Thick on Pump Side of Valve, Piping Beyond Valve to Suit Working Conditions.
"The Engineer"

FIG. 3—PARALLELING OF PUMPS WITH ONE PRESSURE GOVERNOR

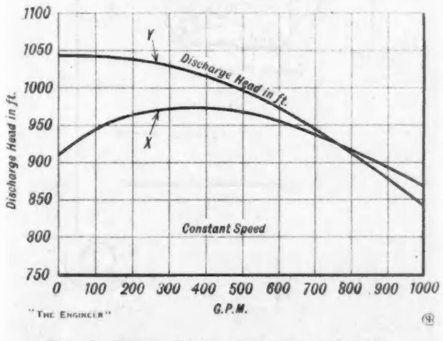


FIG. 2—FEED PUMP CHARACTERISTICS

As soon as parallel operation was attempted, however, these units showed that parallel operation, especially at lower capacities, was extremely unstable, and violent surging of the units and slamming of the check valves occurred. This surging or see-sawing (first one pump taking practically all the load, and the other pump dropping the load, and *vice versâ*), and slamming of checks results from the fact that with two pumps with so-called flat or drooping characteristics discharging into a common main, there are no factors existing in the installation which will influence the pumps to operate on a fixed point of their head capacity curve when the combined output or capacity is constant. It should be remembered that the discharge pressure is the only common controlling factor for two pumps operating in parallel, and with a flat characteristic pump, such as curve X, Fig. 1, it will be noted that for any speed two widely different capacities may be obtained while operating at a fixed discharge pressure.

Thus it will be noted from Fig. 2, curve X, that at constant speed and discharge pressure of 945ft. one pump may operate at a capacity of 100 gallons per minute while the other pump is operating at a capacity of 650 gallons per minute. Now any change in the system such as opening or closing feed checks to boiler will result in a disturbance of these operating conditions. If total feed demand is reduced from the 750 gallons per minute previously delivered, the discharge pressure will tend to rise on the pump previously operating at 650 gallons per minute, and tend to lower on the pump operating at 100 gallons per minute. This will result in the 650 gallons per minute pump hogging all the load and the 100 gallons per minute pump dropping the load with reversal of flow from the pump of higher pressure, and the slamming of the check on the 100 gallons per minute pump. With this pump off the line (operating at shut off) its speed will tend to rise with consequent rise in discharge pressure, and this pump will come back on the line and its higher pressure will cause it to take the load with the other pump previously carrying the load dropping same, due to the fact that when it takes all the load from the other pump its speed and pressure will automatically lower, and it will go off the line with consequent slamming of its discharge check valve.

With few exceptions, the leading manufacturers of this type of unit, both in this country and abroad, held that it was impossible to parallel single-stage pumps, and that they were regarded as "single-purpose" units not suitable for parallel operation. It was contended by one manufacturer that the rising characteristic could only be obtained by a considerable sacrifice in efficiency. These claims, however, have not been substantiated by test, as the rather elaborate tests conducted on pumps of certain manufacture have shown that these rising head characteristic units have higher efficiency than any units of similar type in service.

The manufacturers referred to above, however, stated that they could furnish new impellers for the units they had in service, such that the "flat" characteristic would be changed to a uniformly rising characteristic, and that with the new impellers their pumps would parallel at any capacity.

A uniformly rising head characteristic pump presents no difficulties for parallel operation, because for any given condition at constant speed, there is only one point at which the pump can possibly operate. Curve Y, Fig. 1, shows the rising head-capacity curve obtained by a change in impellers on pumps previously having a flat or drooping characteristic as shown on curve X, Fig. 2.

The Bureau accepted the offer of this company to demonstrate their claims, and the tests conducted fully justified their contentions, and the units concerned paralleled very satisfactorily under all possible operating conditions.

Faced by the established fact that it could be done, other manufacturers have developed modifications, such that all cruisers originally having flat characteristic pumps soon will have pumps with a rising characteristic which will parallel satisfactorily under any capacity condition.

Units essentially similar to those on the earlier cruisers are now being supplied, and it is the purpose of this article to briefly describe the paralleling tests conducted at the Engineering Experiment Station, Annapolis, Maryland, on these units as indicative of the results to be expected from the operation of rising head capacity boiler feed pumps operating in parallel.

The test set up consisted of two No. 5½ Class SFU Buffalo single-stage, double-inlet boiler feed pumps, driven by type BAN Terry turbines. Each pump was fitted with a standard commercial horizontal swing check valve on the discharge and a 3in. Swartout S C excess pressure pump governor.

Fig. 1 shows the diagrammatic arrangement of the test set up using a separate pressure governor for each pump. With this set up satisfactory paralleling is obtained under all conditions. As one pump was cut out by its throttle valve, the other pump would assume the entire load immediately without any marked hunting. When the idling pump was cut in each pump assumed a share of the load immediately without any fluctuation or other difficulties.

To obtain load equalisation, however, it is necessary to have equal excess pressure governor settings. The water actuating lines to the excess pressure governors may be cross-connected for slightly improved load-equalisation characteristics. This set up permits, if desired, running one or more units at full capacity and controlling on another unit.

Fig. 3 shows the diagrammatic arrangement using one excess pressure governor to control two units. Any pumps of similar characteristics will parallel with equal loads at all times with this system of regulation since, in effect, it gives equal steam chest pressures on the turbines and forces the pumps to run at a fixed point on their head capacity curves.

For units located in different compartments this set up would involve too much piping, and if four units were actuated by a single excess pressure governor, the accuracy of regulation at partial loads would probably be poor. The cross-connecting of the pilot valves on Leslie or Foster regulators in effect is identical to one excess pressure governor controlling two or more units, because it assures equal turbine steam chest pressures on both units at all times. This method necessitates load equalisation at all times, and it is impossible to operate one or more units at full capacity and control with one unit where pumps are thus connected.

It was originally intended in connection with this paralleling test to determine the effect of different types of check valves on the paralleling of the pumps. Certain manufacturers stated that the difficulty in paralleling was caused by the check valves. Various types of balanced non-return and cushioned checks were proposed to eliminate the difficulties. However, results of later tests have indicated that the conventional swing check valve is entirely satisfactory with a pump of the correct characteristics, and the drop across this type is about one-tenth the drop across the cushioned vertical lift type. The complications, therefore, of the "balanced" or cushioned type of check valve do not appear to be justified as there is no necessity for other than the simplest type.

Further, with the cushioned checks, in cutting out a pump the check valve will tend to "hang open" until a considerable back flow through the pump being cut out takes place. This results in an appreciable drop in pressure on the discharge main, and when the cushioned check does close a water hammer is set up in the piping. In the case of swing checks no such hang open exists and, consequently, no water hammer results.

An additional test with separate regulators for each pump was conducted with the actuating water for the excess pressure governors taken from the common discharge main beyond the check valves of the two pumps. This resulted in unstable operation, surging of the units, and slamming of the check valves.

It is interesting to note that on three separate tests different observers, among whom was the writer, have observed that apparently the check valve on the pump being cut in on the main line starts to open at about 15 lb. lower pressure than is on the line. The check valves were fitted with an external indicator to show the position of the valve at all times. It seems that if this is a fact, it is caused by the velocity reaction from the pump impinging on the check valve. It, therefore, would seem desirable to locate the check valve as close as possible to the pump diffuser to augment this desirable effect.

It may be concluded that the single-stage, high-speed boiler feed pump having a continuously rising characteristic at constant speed with an increase of approximately 12 per cent. in pressure from rated capacity to shut off (no delivery), will parallel satisfactorily in a set up using conventional swing check valves and connected according to Fig. 1 or Fig. 3.

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* Abstracted from the *Journal* of the American Society of Naval Architects.

CALENDARS, DIARIES, &c.

ASHWELL AND NESBIT, Ltd., Barkby-lane, Leicester.—Wall calendar with daily tear-off slips.

ASSOCIATED EQUIPMENT COMPANY, Ltd., Southall.—Motorists' diary.

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160 B.H.P. Vis-a-Vis Oil Engine.

THE 160 B.H.P. four-cylinder *vis-à-vis* airless injection oil engine herewith illustrated has recently been designed by Mr. H. V. Senior, of the Brush Electrical Engineering Company, Ltd., Falcon Works, Loughborough, for power stations, industrial work, air compressor driving, and marine auxiliary service, and is the first unit of a series of straight-line engines and air compressor units which are to be built by the firm. The range will eventually comprise, besides single-cylinder units, a number of multiple-cylinder units from 120 up to 520 B.H.P. in output, the smaller engines running at 600 r.p.m. and the larger at 330 r.p.m.

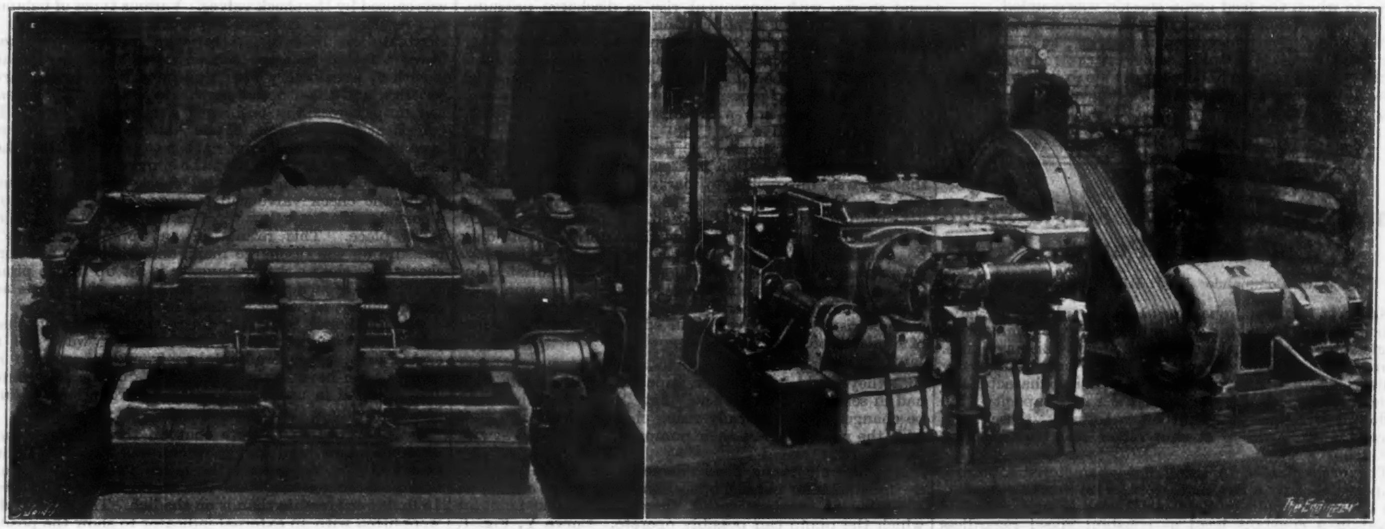


FIG. 1—VIEWS OF 160 B.H.P. 103-kW VIS-A-VIS OIL ENGINE GENERATOR SET

In the engine we illustrate the four cylinders are horizontally opposed, with a stroke of 16½in., giving a designed output of 160 B.H.P. at 440 r.p.m., with a 176 B.H.P. maximum load. As our right-hand illustration above clearly indicates, the engine is belt coupled by means of a Wigglesworth "Texrope" drive to an alternator. It is a Brush, 103-kW, 420-volt machine, which is being supplied to the Downton Electric Light Company, Ltd., and will be run in parallel with an alternator driven by a water turbine. A feature of the set is that when the demand increases the engine and generator speeds can be adjusted to meet the new requirements by fitting appropriate pulleys. During a recent visit to Falcon Works we inspected the engine under test-bed conditions, and noted its general smoothness of running and absence of vibration. We were informed that final fuel consumption figures had not been obtained, owing to adjustments which are being made with the fuel pumps and the sprayer nozzles, but that results of the order of 0·39 lb. of oil per B.H.P. hour under full load conditions are already indicated.

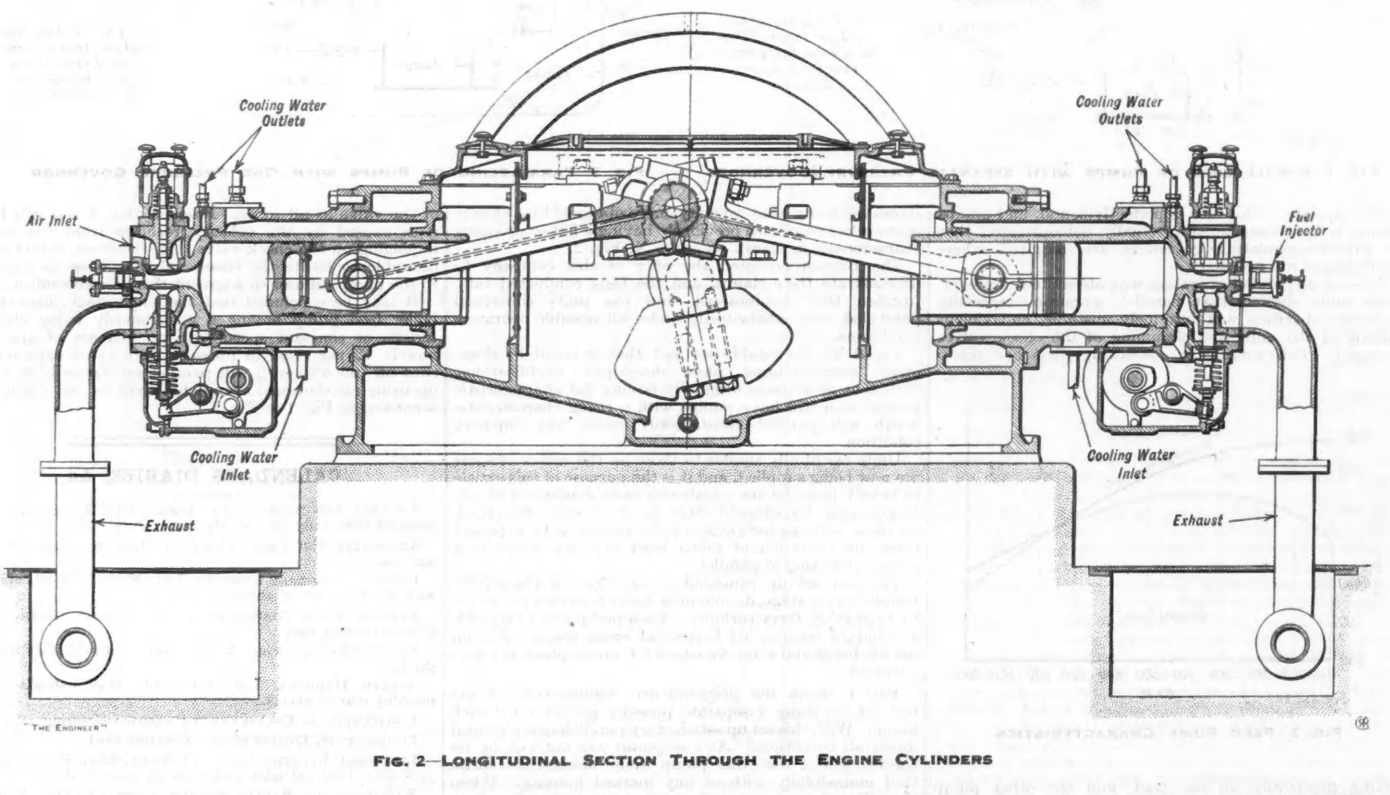


FIG. 2—LONGITUDINAL SECTION THROUGH THE ENGINE CYLINDERS

The outstanding characteristic of the new engine, which is shown clearly in our drawings, Figs. 2 and 3, is the adoption of a compact and completely enclosed bed-plate and crank case, and the enclosure of all working parts. Pressure lubrication at 15 lb. to 20 lb. per square inch is applied to the main crank shaft bearings, and all working parts, only the outboard bearing, which requires less frequent attention, being arranged for oil ring lubrication. Rigidity has been secured by the adoption of a deeper section of bed-plate than usual in normal design, which is reinforced by transverse ribs and is faced on the top to carry a machined oil-tight cover of light construction. On either side of the crank shaft the bed-plate frame is extended in an upward direction, and the horns so formed are tied together by steel bars. The joints of these bars include a special tensioning device, so that the initially tensioned members may ensure greater rigidity and prevent any springing of the bed from taking place The main bearings are each 5¼in. in diameter with a 5¾in. crank pin. The foundation bolts pass right through to the top of the bed-plate, and have concave tops in order to assist in positioning the bed-plate when lowering it into position and to facilitate the easy threading of the nuts. As will be seen from Fig. 2, guarded oil baffle plates are placed within the bed-plate so as to form special oil sumps for the used cylinder lubricating oil, which is thus kept apart from the main lubricating oil supply. The two-throw crank shaft is ground and is made in high-tensile heat-treated steel to the requirements of Lloyd's Register of Shipping specification, and the cranks are fitted with balance weights. Nickel-chrome connecting-rods are used and considerable ingenuity is shown in the special design of large end bearings, which provides a large rubbing surface on the crank pin for both big ends. By removing the top cover complete access is given to all bearings.

The pistons are made of heat-treated aluminium alloy, and are specially long. They carry five pressure rings and one oil scraper ring, while a fully floating type of gudgeon pin is used. Special provision is made for lubricating the pistons completely, but at the same time preventing any lubricating oil from reaching the combustion spaces. The liners are symmetrical castings made in a close-grained nickel cast iron, and are pressed into the cylinder casings and supported by rings forming part of the cylinder casing casting. Both the pressure and water joints are made by the clamping action of the breech ends, and they are visible and easily accessible. The design of the liner and its fastening is such that the forward end is quite free to expand.

We illustrate in Fig. 4 the component parts of one of the breech ends of the cylinder, and a completed cylinder head. The main casting, sections of which are shown in Fig. 2, is of symmetrical design, so as to be free of casting stresses and is made in a cast iron alloy and heat treated. The design is such that there are no ties between the hot walls of the combustion chamber and the cooler walls of the jacket, while the cooling water space is enclosed by a steel breathing plate, which is attached by studs to the fabricated jacket cover. The cover and plate are shown to the right of Fig. 4. The combustion space itself is of a simple symmetrical form, with no dead air pockets, and although the breech end of the cylinder is water cooled, this cooling system is entirely separate from that of the liner, so that a leaky cylinder joint does not allow water to pass to the working cylinder. The cylinders are furnished with relief valves. The cam shafts, which are arranged transversely below the ends of the cylinders, are driven by skew gearing from a central box—see Fig. 5—on the side of the crank case, which serves as a housing for the governor and the lubricating oil pumps and their drives, and also as a support for the fuel pump units and their controls. The cam shaft drives are completely enclosed and are fed from the pressure lubricating system. As Fig. 2 shows, the exhaust valve is directly operated from the cam shaft through an adjustable rocking lever, worked from a hardened steel cam, while the inlet lever is operated by an adjustable short hollow push-rod and lever, which is pressure lubricated, and is accessible by lifting a light cover. The air and exhaust valves are made of alloy steel and the stem of the exhaust valve runs in a long cast iron guide, which is lubricated by a wick feed.

The air starting equipment works in conjunction with a 200 lb. to 300 lb. pressure air receiver, and the air starting valve control gear is connected with the decompression gear which lifts the exhaust valves. The operation is carried out by a single lever, which in its movement passes through the half compression position and gives the initial impulse of air, the further admission being made by the cams. The arrangement of the governor, lubricating oil pump, and fuel pump drives is shown in Figs. 3 and 5. The vertical spindle oil pump is of the gear wheel type, and submerged within the oil tank; it is driven by skew gear from the end of the crank shaft and an extension with an upward gear drive also serves the tachometer and the governor. The oil for the pump passes through an Autoklean filter, and thence to the main oil supply pipe within the bed-plate, which supplies the main bearings and running parts. The pressure within the lubricating system can be controlled by an adjustable relief valve.

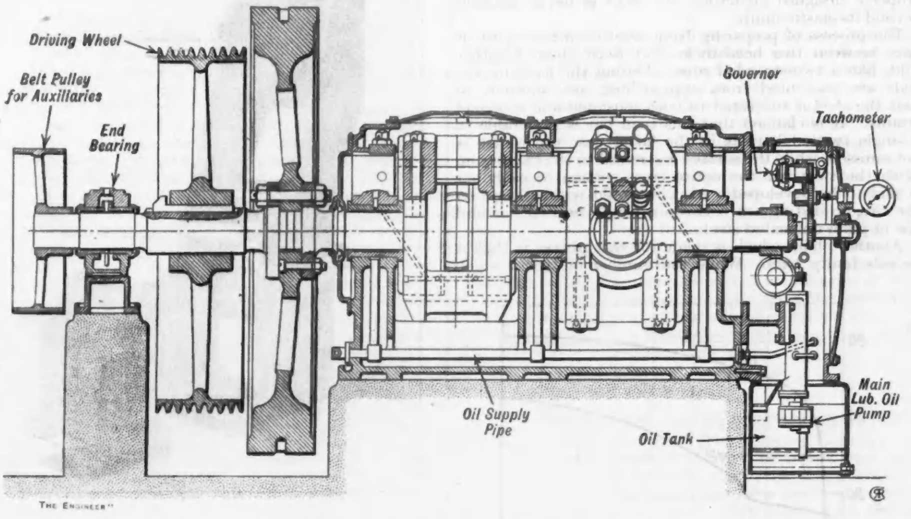


FIG. 3.—CROSS SECTION THROUGH CRANKSHAFT

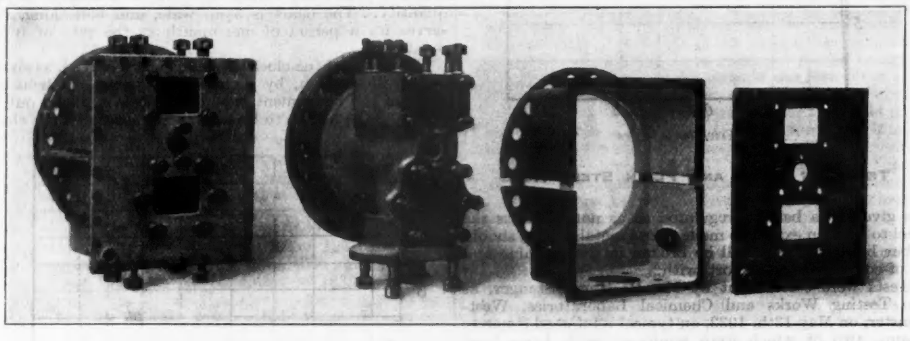


FIG. 4—BREECH END OF CYLINDER WITH FABRICATED STEEL COVER

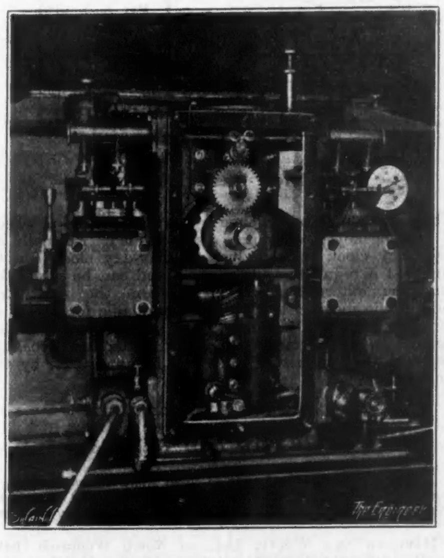


FIG. 5—FUEL PUMPS, AND GOVERNOR

Fig. 5 shows the fuel pump arrangement, which consists of four standard flange pattern Bosch pumps with standard injectors. The fuel pump cams are enclosed within a box with an easily removable inspection cover, and means are provided for putting out of action any one, or more than one, of the four pump units. Each pump has a hand priming lever, which is released by a spring-loaded catch, and the injection period can be varied by a single lever at the side of the pump, which moves over a notched rack. This arrangement permits of a wide choice of fuels being used with appropriate fuel pump settings. The lubricating oil system is also provided with a hand-operated priming pump and spray orifice lubrication for the gear wheels shown in Fig. 5.

The engine we have described was opened up for inspection after a full load run and all the bearings were quite cool. A feature of the design is the enclosure of all parts in casings with removable covers of small size, so that the engine can be conveniently dismantled and re-erected in a small space. Further performance trials are to be made, particulars of which we hope to publish in a later issue.

Some Engineering Works in Czechoslovakia.

MUCH information of interest to British engineers was given by Mr. T. Makemson, the General Secretary of the Institute of British Foundrymen, in a paper which he read, on October 4th, at a meeting of the London branch of that body. He has returned recently from the International Foundry Congress at Prague, which was arranged by the Czechoslovakian Foundrymen's Association, and was attended by some fifteen foreign delegations, of which the British was the largest; and in his paper he gave some of his impressions of foundries, blast-furnaces, and steel works which he visited in Czechoslovakia, during the comparatively short time available to him.

In the first place, he drew attention to the difficulties which that new country experienced immediately after the war, owing to the delimitation of frontiers, the shrinking of the demand for war material, and the comparatively restricted home market. The people had adapted themselves, however, with amazing energy and ability, and their success in the export trade had made them formidable competitors to every manufacturing country in the world. The peak year of the country's prosperity was about 1929; since then the general world conditions, tariffs, and the condition of the exchanges have made the export position more difficult, so that to-day many of the plants are working at considerably less than full capacity.

The first works to which Mr. Makemson referred in his paper were those of the Ceskomoravska-Kolben-Danek, Ltd., at Prague. The company was formed by a merger of three other companies, and its manufactures include steam turbines, generators, transformers, electric motors, water turbines, locomotives, domestic pumps, and brewing machinery.

In a reference to the malleable iron-foundry there, and the annealing of malleable castings in a large gas-fired furnace charged through the roof, which is in sections, he mentioned that cast steel annealing boxes of about 2ft. diameter and 3ft. depth are used, and 0·5 per cent. copper is added to the steel used for making them. It is claimed that their life is prolonged thereby.

A special section of the non-ferrous foundry is devoted to the making of castings in Electron metal, a magnesium and copper alloy with a specific gravity of 1·2 and a melting point of 520 deg. Cent. Crank cases and other automobile castings, commonly made in aluminium, are being manufactured in this metal. It is the experience at these works that a casting temperature of just over 600 deg. Cent. gives the best results. The metal is melted in iron pots and poured into the casting ladles, which are allowed to stand, each pot with a pyrometer inserted, until the metal has cooled to the correct casting temperature. The method of running the moulds is also important. The vertical down runners consist of cores, each core forming three, or, in some cases, four narrow down gates. Horizontal gates carry the metal to each side of the mould, and the ingate is almost continuous. Chills and denseners are employed extensively. Where high corrosion resistance is required, castings of this metal are dipped in a solution of potassium bichromate to increase their resistance, and they then attain a bright golden colour.

Two of the four bays of the iron-foundry are devoted to heavy work in dry sand and loam, and the moulding practice appears to be similar to our own. For smaller work on a repetition basis there is a number of moulding machines, practically all of the press turn-over type, and in this section of the foundry there are gratings in the floor with underground conveyors for the return of used sand.

The pattern shop is a magnificent building on the ground floor, containing an abundance of machines of modern type, and in good condition. Timber is stored in the basement, and the stores are equipped with a very complete timber-drying plant, consisting of three kilns and the necessary steam-raising and air-heating plant. Planks of unseasoned timber are loaded into a truck which is run into the kiln, and there saturated with steam for five hours, by which time the steam is considered to have driven out the natural sap. By an arrangement of valves, the same steam is then used to heat air which is circulated through the kiln for approximately seven days at a temperature of 50 deg. Cent., and dries out the moisture with which the timber has been saturated. The boiler plant supplying the steam adjoins the kilns, the fuel consisting almost entirely of shavings, waste timber, and other rubbish from the pattern shop. This is an extremely fine plant, and though much of the dry timber was warped, there did not appear to be any considerable cracking, and it was claimed that the warping did not cause trouble.

The general impression of this works was that the equipment is good, but not particularly novel; but the work, as a whole, is of the highest quality. The company is obliged to endeavour to create a large export market, and it is essential that the plant be sufficiently flexible to cover a very large variety of work. It is difficult to specialise to a considerable extent; therefore, the policy is to have good plant, but not highly specialised.

Another works visited was that of the Vitkovice Mining, Steel and Ironworks Corporation, at Vitkovice, a town adjoining Maraska-Ostrava, in the most extensive coal-field in the country. The company manufactures pig iron, steel and iron and steel castings; it has an extensive constructional and general engineering business, and operates collieries, coke ovens, ore mines, and a refractory-manufacturing plant. The iron and steel works alone cover an area of 10 square kilometres.

There are two blast-furnace plants, one with three furnaces, and another, nearly a mile away, with two furnaces, the two plants being connected by a gas main 1¼ kiloms. long and 9ft. in diameter, and a blast main of the same length, 5ft. in diameter. Also, there are 2½ kiloms. of gas mains to convey blast-furnace gas to various points in the works. There is an extremely ingenious electrolytic gas-cleaning plant, claimed to be the first of its type in the world.

There are two open-hearth steel-making plants, well laid out and splendidly equipped, and the rolling mills are of very up-to-date design and lay-out. The latter consist of a roughing mill, an armour-plate mill, three other mills for plates and sheets, and mills for rails, sections for structural work, and various mills for strips and rods. There is also a tube mill. The equipment is designed for quick rolling to avoid re-heating as far as possible, and in a test the time taken from weighing the ingot before entering the roughing mill to the finished product about 100 mm. square in section was 5 min. 2 sec. The rolling mill equipment is electrically driven, and Mr. Makemson described it as a wonderful display of modern engineering.

After a brief reference to the ironfoundry (which is said to be the largest in Czechoslovakia), and the machine shops, erecting and constructional shops, and the forges, Mr. Makemson drew attention to the considerable economies which have been effected in the consumption of fuel by the Vitkovice Company. In 1929 the entire consumption of fuel, including coal and gas, per ton of ingots produced, was 45·7 per cent. of the consumption in 1920. This result was accounted for partly by the larger output, which, in 1929, was nearly double that of 1920, but it was due mainly to reorganisation directed to the utilisation of surplus energy. Blast-furnace gas is stored in a gas-holder of 50,000 cubic feet capacity, and coke-oven gas in a smaller holder. Blast-furnace gas is used for heating the coke ovens, and the coke-oven gas is consumed in the open-hearth furnaces. Blast-furnace gas is used in the blowing engines and for driving ten large double-cylinder gas engine sets for the generation of electric current. The distribution of the blast-furnace gas is: To blast-furnace stoves, 27 per cent.; boilers, 1·2 per cent.; blowing engines, 10·7 per cent.; electric current generators, 24·8 per cent.; coke ovens, 10·8 per cent.; open-hearth plants, 7·7 per cent.; miscellaneous purposes and losses, 17·8 per cent. The coke-oven gas is distributed to the open-hearth plants to the extent of 56·7 per cent.; rolling mill, 14·5 per cent.; tube mill, 13·2 per cent., and miscellaneous, 15·6 per cent. Additionally, 420 tons of coal are burned daily in gas producers when the works are in full operation, the producer gas being used for the open-hearth plants and the rolling mill. Waste heat boilers are employed extensively for steam raising; the temperature of the cooling water in the gas engines can be raised above the usual temperature without detriment to the engines, and the hot water from the gas engines is used for heating purposes in the works and the works hospital.

Another establishment visited was, of course, the Skoda Works at Pilsen, which, until the end of the war, was one of the principal sources of supply of armaments to the Austrian Empire, and is now, perhaps, the most impressive engineering factory in Czechoslovakia. In view of the necessity for finding different employment for this huge factory after the war there were considerable alterations in the structure of the company, and other industrial undertakings were absorbed. In 1929 the company had nearly 40,000 employees. The range of the company's productions includes metallurgical products, general engineering (which includes prime movers, steam boilers, various types of engines, aeroplanes, river craft and machinery for special purposes), electrical engineering, war material, and mining products.

In a reference to the steel foundry, Mr. Makemson drew particular attention to the section devoted to small castings. Here moulds are made on press turn-over machines and sand is supplied by an overhead conveyor with a hopper and chute over each machine. Each moulder in this section is provided with a short roller gravity conveyor alongside his moulding floor to assist in putting down the moulds. Steel snap flasks are used extensively, and most of the moulds are of skin-dried green sand. Risers are cut off by oxy-acetylene torches and also by saws.

The ironfoundry, one of the largest engineering foundries on the Continent, Mr. Makemson described as an enormous well-lighted, clean and well-arranged building with plenty of room and an abundance of handling equipment. The melting plant consists of six cupolas, varying from 24in. to 64in. internal diameter, and one 4-ton electric furnace, which is used in connection with a duplex process for melting an abrasion-resisting iron for motor car cylinders. This metal is said to contain about 1·8 per cent. silicon and 0·3 per cent. titanium. An acid-resisting alloy containing 16 per cent. silicon and a small quantity of titanium is also manufactured. Both alloys are patented.

Moulding machines are employed extensively in this foundry also, but although numerous fairly light castings are made in considerable quantity, there is little approach to so-called mechanisation. The core-making department is magnificently equipped with handling equipment, stoves, and benches. Oil sand cores are used almost exclusively for the lighter castings; and Mr. Makemson mentioned some oil pump castings where chills were inserted in the cores to prevent porosity at vital points. In one case the chill was embedded in the sand, so that there was a layer of sand between the chill and the casting. A section of this foundry is devoted to the training of apprentices on ordinary production jobs, selected according to their capabilities.

In the non-ferrous foundry die casting is carried out in a pressure die casting machine, where the metal is melted, but is never allowed to become thoroughly liquid, and it is poured into the machine in a pasty condition by a hand ladle. The dies are then subjected to a pressure of from 180 to 200 atmospheres. The output of the machine is said to be 800 small castings per hour. The advantages claimed for this method are soundness, longer life, more accurate finish, and a saving in runners.

All runners, risers, brackets, &c., in the Skoda foundries are standardised. Before any pattern is sent into the foundry it is examined by specialists, the position of runners, risers, &c., marked upon it, and the standards to be used are specified. It is claimed that considerable saving in defective castings is effected thereby, and the lessons learned from defects can be made use of subsequently in an easy and systematic manner. The general tendency in the steel foundry in particular appeared to be in the direction of using a large number of smaller risers, as against a smaller number of large ones.

The pattern stores, a building of about eight storeys, said Mr. Makemson, is most amazing. Each set of patterns is carefully placed in a rack with a space between every two sets of patterns to prevent confusion. It is claimed that the expenditure of so much capital on this equipment is justified, in that the cost of repairing patterns and making good lost pieces before returning to the foundry has been almost entirely eliminated. There is a timber drying plant in these works also.

A well-equipped school for the technical instruction of apprentices is in operation. Foundry workers appear to receive instruction, not only in practical matters, such as gating and rising, but in reasonably advanced metallurgical subjects. Practical instruction in the making of large moulds is given with the aid of wood and plaster models of the moulds and cores. Instruction in safety-first methods is also given.

In a general reference to costs of production, he said it was difficult to compare those applying in Czechoslovakia with those applying in this country, owing to variations of the exchanges and the different conditions. It appeared, however, that wages in Czechoslovakia are similar to or even slightly higher than those paid in this country, at the present rate of exchange, and on the whole there does not seem much difference in the cost of raw materials. Moulding sand, however, can be obtained very cheaply there; there are excellent deposits of natural sand within easy access of the industrial centres, and the cost of sand delivered to the foundry works out at about 5s. or 6s. per ton.

Isteg Steel.

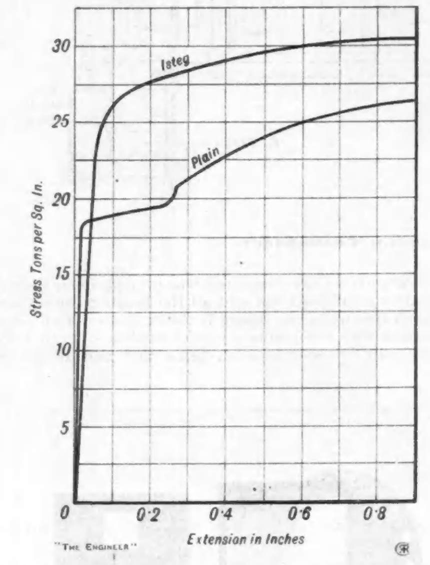
The steel which is used for the reinforcement of concrete works under rather different conditions to that of most other structures, as being associated with a practically inelastic material, it is essential that it should not extend under working loads; otherwise permanent cracks would be produced in the concrete of any member subject to tension, and the opportunity for corrosion provided. For this reason it is usual to employ steel of a high elastic limit for concrete reinforcement, and specifications are sometimes rather severe in this direction.

Isteg Steel Products, of 40, Broadway, Westminster, have, however, discovered a means whereby ordinary mild steel may, they claim, be used to equal advantage as "hard" steel.

The idea, which has found application on the Continent for some years past, is to pre-stress the mild steel, before it is put in place, to such an extent, that its elastic limit is passed. The metal is then allowed to rest before being put in service. The result is that a considerably higher load can be supported before the new elastic limit is passed. We reproduce a graph, which shows how a steel, having a very definite elastic limit of about 17 tons per square inch, may be so improved by the Isteg process that its elastic limit is only approached at about 25 tons per square inch. The test pieces in this case had a gauge length of 24in. It is said, also, that the ultimate strength of the bar is slightly increased, but this is, of course, of no great import in reinforced concrete work, as, in a properly designed structure, the steel is never stressed beyond its elastic limit.

The process of preparing Isteg steel is to fix a pair of bars between two headstocks and twist them together cold, like a two-stranded rope. During the twisting the ends are prevented from approaching one another, so that the steel is subjected to both tensional and torsional strains. It is claimed that this twin bar is preferable to a single twisted bar, as in the latter case the centre is not stressed, while the surface is stressed to the maximum. With the twin bar the entire cross section of each bar is said to be developed. Also, it would not be easy, on the site, to distinguish between a single twisted bar and one of plain untreated steel.

Another claim which is made for the process is that it reveals faulty bars. While the number of twists which are given to a bar are regulated so as not to stress the steel to such an extent to make sound metal brittle, should a bar be defective it will be broken in the machine and is, of course, discarded forthwith.



TESTS OF ISTEG AND PLAIN STEEL RODS

Tests were carried out by Mr. R. Harry Stanger, at the Testing Works and Chemical Laboratories, Westminster, on May 13th, 1933, on typical reinforced concrete beams, two of which were reinforced with Isteg bars, and the other two with ordinary bars. In each case the steel was ordinary commercial quality bar, supplied by Dorman, Long and Co., Ltd., and both sets of bars were from the same cast. The beams reinforced with ordinary bars had 58 per cent. more reinforcement than the beams with Isteg bars, and yet the Isteg beam stood the same load and gave an average stress of 70,000 lb. per square inch for the Isteg bars.

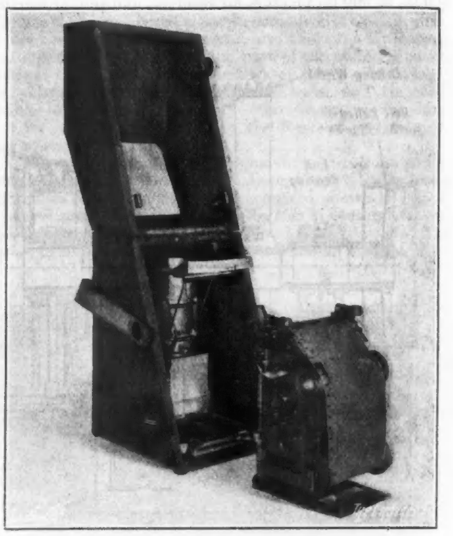
It is of interest to note that tests carried out at the University of Prague eighteen months ago, using similar beams with the same concrete section, reinforced with Isteg bars of Czecho-Slovakian open-hearth steel, gave stresses of 68,000 lb. per square inch.

A Recording Insulation Tester.

When drying out parts of electrical machines and apparatus, such as armatures, field coils, and transformer coils, a knowledge of the insulation resistance during the process is of considerable importance. Frequently, these parts are dried in a vacuum oven, and observation and periodic tests of the insulation resistance have hitherto presented difficulty, but the Evershed and Vignoles recording Megger insulation tester, shown in the accompanying illustration, enables the process of drying out to be observed, and to be permanently recorded. The curve has been reproduced from a chart made by a recording Megger insulation tester during the process of drying out a set of field coils for a small motor, and it clearly shows how the insulation resistance increased with time. When the coils were placed in the oven the insulation resistance was in the neighbourhood of 1000 ohms, and, as the curve indicates, it rose to 36 megohms in the course of 2½ hours, and finally to 40 megohms. The exact time necessary for drying out any particular piece of apparatus can readily be established, and with this knowledge work can be passed through the drying plant in the minimum period consistent with satisfactory drying.

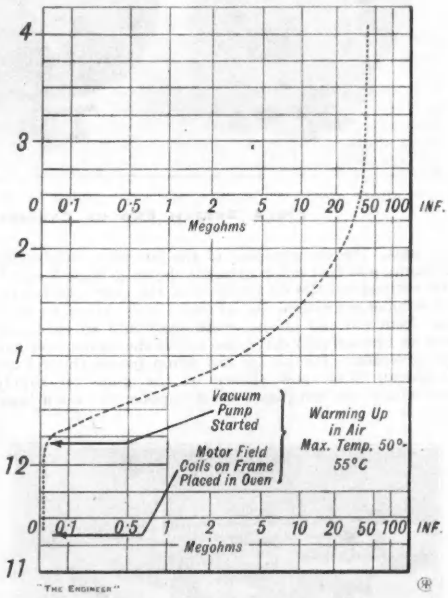
When measuring high resistance, the amount of current flowing through the instrument is very small. It has therefore been necessary to develop a sensitive type of recorder. A tapping or typewriter system of marking or recording has been adopted, so that no load is imposed upon the instrument movement, and a high degree of sensitivity and accuracy is obtained. As the instrument is a moving coil ohmmeter, the readings are independent of voltage variations. Instruments are available for 100, 250, 500, and 1000 D.C., with various megohm scales up to 1000 in the case of the 1000-volt instrument. For operating the instrument D.C. at the testing pressure is required. The amount of current does not, however, exceed 12 milliampères at the lowest reading, and in some cases it is found convenient to employ a well-insulated battery or to work from A.C. mains through a transformer and rectifier. If there is considerable electrostatic capacity in the object under test, special means must be taken to ensure a steady voltage.

The illustration shows the instrument with the clock and recorder removed. On opening the case the supply is automatically interrupted, so that there is no risk of the operator receiving a shock. When the recorder is in use the pointer is depressed by a sharp tap at intervals of one minute on to a typewriter ribbon, thus producing a dot on the chart, which usually travels at the rate of 1in. per hour. Consequently there are sixty dots to the inch, giving a practically continuous line for a slowly varying quantity. The chart is 3½in. wide, and 65ft. long, and serves for a period of one month at the rate of travel mentioned.



RECORDING INSULATION TESTER

The whole of the clock mechanism is removed, as shown in the illustration, by depressing a spring catch at the front of the instrument, when the clock is pulled out by means of the handle to be seen at the bottom of the clock. The chart can be set to time by turning a knurled wheel. A winding key is, of course, also provided. Normally an eight-day clock is used, but a thirty-day clock can be supplied if required. The chart speed can be varied by changing external driving wheels on the right-hand side of the recorder. Wheels are available for speeds of ¼in., ½in., and 1in. per hour. The instrument is guarded against its own surface leakage, and errors due to leakage between the connecting leads can be eliminated by the guard terminal.



INSULATION RESISTANCE CURVE

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

Harland and Wolff, Ltd., of North Woolwich, have received from the Associated Portland Cement Manufacturers, Ltd., an order for a small tug, which is to be fitted with a 60 B.H.P. British Kromhout marine oil engine.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Alfred Herbert, Ltd., have purchased the entire business and plant of the Vidal Engineering Company, Ltd., Thornton-road, West Croydon. It is equipped for the production of electric drills, grinders, polishers, fractional horse-power motors, bench lathes, suds pumps, &c.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Continental Steel Trade.

In no department of the iron and steel market have conditions changed more during 1933 than in the Continental steel department. At the beginning of the year the reconstructed Cartel had only commenced to function, and plans were barely outlined for the international sales organisations which later in the year became effective. Notwithstanding the opposition with which the markets met the selling comptoirs, these organisations appear to have established their positions for the time being, although there is still a certain amount of work to be done in this direction. The latest move of the Cartel has been to set up in the British market pools for the sale of joists, bars, and plates, composed of one representative of each of the existing Continental selling organisations in this country. The British merchants in future will have to buy from these pools, which will sell at the official works prices. So far, no alteration in the Continental steel quotations has followed this arrangement, which, in fact, is hardly yet in working order. It is interesting to compare the prices existing at the beginning of this year with those which now rule. Merchant bars were then quoted at £2 7s. gold or £3 8s. 6d. paper; joists at £2 2s. gold or £3 1s. paper, which was only 1s. higher than sheet bars at £2 1s. gold and £2 19s. 6d. paper. Plates, $\frac{3}{16}$in. and $\frac{1}{4}$in., were quoted down to £2 15s. gold or £4 paper. On the Continent it was asserted that these extraordinarily low prices would have continued to rule had it not been for the resistance offered by the international sales organisation, and it is possible that there is some truth in this view. The quotations at the end of December were:—Merchant bars, £2 15s. to £3 gold, £4 2s. 6d. to £4 10s. paper; joists, £2 16s. 6d. to £2 19s. gold, £4 4s. 9d. to £4 8s. 6d. paper; and sheet bars, £2 8s. gold, £3 12s. paper. Plates, $\frac{1}{4}$in., were quoted at £3 10s. gold and £5 5s. paper for the British market, and £3 18s. 6d. gold and £5 18s. 6d. paper for other markets; whilst $\frac{3}{16}$in. were quoted at the same price for the British market and £4 1s. gold or £6 1s. 6d. paper for other markets.

Pig Iron.

The change in the position of the iron and steel industries is nowhere more apparent than in the pig iron department. At the end of 1932 there were sixty furnaces in blast, whilst at the end of last November, which is the latest date for which official figures are available, seventy-nine furnaces were operating in this country. Production last year averaged 297,800 tons per month, whilst for the first eleven months of 1933 the average monthly output was 309,700 tons. The situation on the North-East Coast at the beginning of 1933 was unsatisfactory, as it was known that the producers were carrying heavy stocks. The suggestion that the pig iron warrant market on the London Metal Exchange, which had ceased to exist since the early days of the war, should be reopened to relieve the situation, was being discussed. In order to obtain business, cheap prices were quoted in Scotland, orders having been accepted at less than 50s. f.o.b. Middlesbrough. The quotations for Cleveland No. 3 foundry were 58s. 6d. for home and export, but less was taken for export if a fair order was in prospect. To-day the position is that all the stocks have been either dispersed or sold and the current production is not sufficient to meet the requirements of the market. So tight is the position that within the last week users have had to bring Midland iron into the district, whilst the producers are contemplating lighting up fresh furnaces so soon as supplies of blast-furnace coke can be assured. Prices also have increased to 62s. 6d. for No. 3 foundry for home delivery, and under the prevailing conditions export business has little attraction for the makers. For Scotland the minimum prices are 65s. 3d., d/d Glasgow, and 62s. 3d., d/d Falkirk. The best that could be said of the Midland pig iron market a year ago was that orders showed a tendency to expand, but not to a sufficient extent to make an impression upon the heavy stocks in makers' hands. It is true there have been no changes in prices for Midland iron, but the position has greatly improved through the reduction of the stocks which are now comparatively small, and the makers are entering the New Year with well-filled order books. In Scotland at the end of 1932 only two furnaces were in blast against ten at the present time. The price of Scottish iron, however, is about 2s. 6d. lower than at the beginning of last year. The change has been scarcely less remarkable in the case of hematite. Most of the stocks in the makers' hands are sold forward, and the current make is so well taken up that it is anticipated that production will have to be increased early in the New Year. Prices have advanced from 59s. at the end of 1932 to 63s. for No. 1 and 62s. 6d. for mixed numbers.

Semi-finished Steel.

The most notable features of the semi-finished steel market have been the tightening in supplies, the advance in prices, and the establishment by the Continental Cartel of a selling organisation for the London market which deprived the British merchants of any share in sale of foreign semis. The quotations at the beginning of the year were for British billets £4 17s. 6d.; to-day the quotation is £5 10s. The price for Continental billets in January, 1933, was £2 18s. to £2 19s. 6d. paper, whilst now it is approximately the same as that for British material. The business now being transacted consists chiefly of odd parcels. Consumers, however, are exercising considerable pressure upon the producing works and in some cases complaints are heard of the latter being late with deliveries. Practically all the producing works are so well off for orders that they can quote only for extended delivery, and on the North-East Coast the earliest date mentioned is February. Premiums are now being asked on forward business, and practically all works quote £5 10s. and some ask 2s. 6d. more for billets. The call for sheet bars is not so insistent and the makers are able to offer near delivery. Prices also remain unaltered at £5 to £5 5s. The tightness in the position has been accentuated by the withdrawal of some Continental works from the market. The quantities of foreign material now being offered are comparatively limited. The quotation for Continental billets varies according to the district from £5 to £5 10s. and for sheet bars it is about £5; but these prices, which include freight and import duty, cannot be satisfactory to the foreign makers. Most of the Continental material which has been offered recently has been billets of German origin, and has consisted chiefly of large sizes. The recent increase in the price of British hard steel billets has had no effect upon the demand, and makers are finding specifications against contracts coming freely to hand. It is noticeable of late that there has been a more active request for acid billets.

Scotland and Lancashire.

The Scottish steel trade at the end of 1932 was in a depressed condition. The shipping industry, upon which the steel trade is greatly dependent, had seldom been so badly off for orders, and in the first month of the year only one contract, and that for a small cargo steamer, was placed with Clyde yards. Little new work had been arranged which was likely to give employment to the construcional engineers, whilst the works dependent upon the railways had few orders on their books to carry over into the New Year. The re-rollers were complaining of the scarcity of business and of keen competition. Conditions, however, steadily improved during 1933, and the industry can look back upon a year's steady progress. The recent orders given out by the railways for locomotives and wagons, the partial revival of the shipbuilding industry, and the orders for engineering contracts which have been placed recently, will enable the Scottish steel works to enter 1934 in a better position than for many years past. For the time being many of the steel works have not yet received specifications as a result of recent orders, but they are assured of this business in the New Year and, in addition, there is a confident anticipation that work will be resumed on the Cunarder, which later on should provide orders for sheets and some of the lighter descriptions of steel needed for ship construction. Featureless conditions marked the opening of 1933 in the Lancashire market. Most of the consuming industries in the district were short of orders, and this was reflected in a poor demand for steel materials. There was a noticeable lack of orders from the constructional engineers, and so far as could be seen little prospect of any increase in activity. Small steel bars were quoted at £6 15s., whilst Continental joists were being offered at £5 5s. d/d compared with £8 7s. 6d. for British joists. At the end of the year most branches of the Lancashire industry are busy and the lighter ones, particularly the re-rollers, are well sold forward. The price of small steel bars has increased to £7 5s. to £7 10s. and competition from the Continent has practically ceased. The structural engineers, although they are not so well employed as a few weeks ago, are entering 1934 with really excellent prospects.

The North-East Coast and Yorkshire.

In no district in the country has the improvement which has taken place during 1933 been more noticeable than on the North-East Coast. A year ago the volume of work in hand was, to say the least of it, disappointing, and although it was said that the prospects for 1933 were promising, it was not expected that any notable change would take place until well into the second quarter. The steel works, however, were just beginning to feel the effects of the tariff upon semi-finished steel and the production of this class of material was being increased. Constructional engineering shops were poorly provided with work. During the year the situation has been radically altered and so strong is the demand for billets and sheet bars that the producers are booked up until February, and in the closing weeks of the year fresh steel furnaces had to be put into operation to maintain the supply. The constructional engineering shops are busy and are carrying good orders into the New Year. The same applies to the railway departments and most of the other sections of the trade, excepting perhaps the sheet works. Even the shipbuilding industry, which has suffered acutely from the depression, shows signs of improving and fresh orders are expected to materialise in January. In Yorkshire the situation at the end of 1932 was viewed with a restrained optimism rather than with confidence. Complaints were general of price cutting to obtain orders for basic billets, and the most that could be said of that department was that the rate of production was fairly well maintained. The works catering for the railways were only moderately busy and disappointment was felt at the failure of the demand for alloy steel sheets to develop. The heavy engineering industries also had a great deal of their plant lying idle. The situation began to show an improvement towards the end of the first quarter and steadily increased until the production of steel in Sheffield expanded and was recently stated to be about 1000 tons per week higher than a year ago. The re-rollers in particular have been busy, some of them operating almost at capacity, whilst the engineering shops, owing to the large orders for chemical and other machinery, are well employed. The orders given out to the railways have entirely changed the situation in that department, which is busier than for years past.

Current Business.

It is announced that Scott's Shipbuilding and Engineering Company, Ltd., of Greenock, has secured an order for passenger and cargo motor ships for a London firm. The London and North-Eastern Railway Company's order for chairs has been distributed between firms at Nottingham, Blaydon-on-Tyne, Middlesbrough, Thornaby-on-Tees, and Alloa. The order was for about 4000 tons of cast iron permanent way chairs. The London, Midland and Scottish Railway Company have announced that their rolling stock programme for 1934 will include orders for 232 locomotives, 159 locomotive boilers, 674 carriages, and 5365 wagons. The total sum which will probably be spent by the L.M.S. upon improvements and renewals will amount to £8,400,000. This, with the programmes of the London and North-Eastern, the Great Western, and the Southern railway companies, will involve a total expenditure of £14,450,000. The Department of Overseas Trade announces that the following contracts are open for tender:—South African Railways and Harbours, supply and delivery of structural steel for an engine shed at Bramfontein (Johannesburg, January 8th); Egypt, Ramleh Electric Railway, Alexandria, garage equipment (Alexandria, January 15th); Southern Rhodesia, Municipality of Gwelo, steam-raising plant, including one water tube boiler with integral superheater, mechanical stoker, soot blowers, feed regulator, and all accessories, one induced draught plant, steam and feed piping with pumps (South Africa, February 6th); Municipality of Bulawayo, one 4000-kW turbo-alternator, switchgear, and transformers (Bulawayo, February 1st).

Copper and Tin.

Conditions in the year 1933 have not been very favourable for the non-ferrous metal markets. At times copper prices have shown a strong tendency to advance, but the financial situation in most markets and the exchange fluctuations which followed the departure of the United States from the gold standard has made business difficult and created a lack of confidence amongst consumers. At the end of the year, however, a sharp burst of buying occurred, some of which was undoubtedly of a speculative character, and prices advanced sharply, but as this movement followed a reaction in prices, the levels ruling at the close of the year were little above those in force a few weeks previously. The statistical position of the metal has certainly improved, largely owing to a vigorous curtailment of output. At the end of 1932 the stocks in the producers' hands were estimated at about 700,000 tons, and during the year these have been reduced to about 640,000 tons. . . . The gradual tightening of the control of the tin position by the International Pool has been the principal feature of the market during the past year. Early in 1933 it was stated that the International Pool held about 21,500 tons of tin, and for a time it seemed as though it would be some time before this accumulation was disposed of. The heavy buying, principally by America, but also by speculators on the Continent, which followed the abandonment of the gold standard by the United States, enabled a considerable quantity of this metal to be disposed of, and at the end of November it was stated that the total quantity in the hands of the Pool did not exceed 8000 tons. At one time during the year the American demand caused a drain upon the stocks in Great Britain, which was reflected in a considerable advance in prices, and at the end of December the price was below the highest touched during the American buying movement. As the quotation was £148 at the beginning of last January, the advance to a price of £227 at the close of the year must be considered a satisfactory movement. The year opens with sound prospects, since the statistical position appears to be steadily improving, and the industrial demand is reported to be expanding.

Lead and Spelter.

Although the position in the lead market has improved during the past year, its chief characteristic has been the steadiness of the quotations. At the beginning of the year the price was £10 15s., and although the quotation advanced at times to nearly £14, the year closed with the price at £11 7s. 6d. It is perhaps surprising that values did not appreciate to a greater extent, since during 1933 the consuming trades were busy and the demand for the raw material was in excess of anything known for several years. The activities of the cable makers were not much in evidence, owing to the completion of the grid scheme, but the manufacturers of lead pipes and sheets were working at high pressure, and the battery trades also absorbed considerable quantities of the metal. Stocks, however, were heavy, and perhaps the producers showed wisdom in keeping prices low, and thereby stimulating buying for industrial purposes. . . . The outlook for the spelter market at the commencement of 1933 was regarded favourably, as it was generally understood that consumption was in excess of production, and although heavy stocks existed in the makers' hands, it was believed that the comparatively low price of the metal—£14 17s. 6d.—would result in these being gradually disposed of. This position has ruled during the greater part of the year, and although prices have moved within a comparatively narrow margin, the highest point touched being just over £17, the market has always had a healthy appearance. The quotation at the close of the year was about £15, but the producers evidently regard the future with confidence, as the existing arrangements regarding production and quotas are to be continued until the end of June. At the end of November the stocks had dropped to 128,000 tons, or more than two months' supply. The weakest spot in this market during the whole of the year was the poor demand from the galvanising trades. On the other hand, the brass industries were actively employed during the latter part of 1933, and took considerable quantities of spelter. The Continental market also shows signs of improving towards the end of the year, so that the spelter market enters the New Year in a fairly satisfactory position.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos. ..	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
Midlands—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry ..	3 6 0	—
,, ,, Forge ..	3 1 6	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto ..	3 7 6	—
No. 3 Foundry, ditto ..	3 5 0	—
Basic, d/d	3 6 0	—
N.W. Coast—		
Hematite Mixed Nos. ..	3 15 6 d/d Glasgow 4 0 6 ,, Sheffield 4 5 6 ,, Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Midlands—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.) ..	12 0 0	—
Nut and Bolt Bars ..	6 15 0 to 7 10 0	—
Scotland—		
Crown Bars	9 15 0	9 5 0
Best..	10 5 0	9 15 0
N.E. Coast—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars ..	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
London and the South—		
Angles	8 10 0	7 7 6
Tees..	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels..	8 15 0	7 12 6
Rounds, 3in. and up ..	9 10 0	8 7 6
,, under 3in. ..	7 10 0	—
Plates, ⅜in. (basis) ..	9 0 0	7 15 0
,, 5/16in.	9 5 0	8 0 0
,, ¼in.	9 10 0	8 5 0
,, 3/16in.	9 15 0	8 10 0
,, ⅛in.	9 7 6	8 5 0
North-East Coast—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels..	8 12 6	7 12 6
Rounds, 3in. and up ..	9 7 6	8 7 6
,, under 3in. ..	7 7 6	6 10 0
Plates, ⅜in.	8 15 0	7 15 0
,, 5/16in.	9 0 0	8 0 0
,, ¼in.	9 5 0	8 5 0
,, 3/16in.	9 10 0	8 10 0
,, ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in. ..	8 5 0	7 12 6
Midlands, and Leeds and District—		
Angles	8 7 6	7 7 6
Tees..	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels..	8 12 6	7 12 6
Rounds, 3in. and up ..	9 7 6	8 7 6
,, under 3in. ..	7 10 0	6 10 0
Plates, ⅜in. (basis) ..	8 17 6	7 15 0
,, 5/16in.	9 2 6	8 0 0
,, ¼in.	9 7 6	8 5 0
,, 3/16in.	9 12 6	8 10 0
,, ⅛in.	9 2 6	8 5 0
Boiler Plates, ⅜in. ..	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
Glasgow and District—		
Angles	8 7 6	7 7 6
Tees..	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels..	8 12 6	7 12 6
Rounds, 3in. and up ..	9 7 6	8 7 6
,, under 3in. ..	7 15 0	6 15 0
Plates, ⅜in. (basis) ..	8 15 0	7 15 0
,, 5/16in.	9 0 0	8 0 0
,, ¼in.	9 5 0	8 5 0
,, 3/16in.	9 10 0	8 10 0
,, ⅛in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees..	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels..	8 12 6	7 12 6
Rounds, 3in. and up ..	9 7 6	8 7 6
,, under 3in. ..	7 10 0	6 10 0
Plates, ⅜in. (basis) ..	8 17 6	7 15 0
,, 5/16in.	9 2 6	8 0 0
,, ¼in.	9 7 6	8 5 0
,, 3/16in.	9 12 6	8 10 0
,, ⅛in.	9 7 6	8 5 0
Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees..	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels..	8 17 6	9 0 0
Rounds, 3in. and up ..	9 12 6	9 15 0
,, under 3in. ..	7 10 0	8 0 0
Plates, ⅜in. (basis) ..	9 0 0	9 2 6
,, 5/16in.	9 5 0	9 7 6
,, ¼in.	9 10 0	9 12 6
,, 3/16in.	9 15 0	9 17 6
,, ⅛in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G to 13-G., f.o.r. ..	8 15 0	8 15 0
14-G to 20-G., d/d ..	10 0 0	9 0 0
21-G to 24-G., d/d ..	10 5 0	9 5 0
25-G to 27-G., d/d ..	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots ..	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
,, £11 5s. 0d., f.o.b. other markets.
,, Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/6 to 16/9.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic Soft (25·41% C.)	6 0 0
,, Medium (0·42% to 0·60% C.)..	6 17 6
,, Hard (0·61% to 0·85% C.) ..	7 7 6
,, ,, (0·86% to 0·99% C.) ..	8 7 6
,, ,, (1% C. and up)..	8 17 6
Soft (up to 25% C.), 500 tons and up..	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t. ..	8 10 0
,, Light, f.o.t...	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
,, ,, 6 p.c. to 8 p.c. ..	£21 12 6	7/–
,, ,, 8 p.c. to 10 p.c. ..	£21 12 6	7/–
,, ,, Specially Refined ..		
,, ,, Max. 2 p.c. carbon	£34 10 0	9/–
,, ,, ,, 1 p.c. carbon	£35 12 6	10/–
,, ,, ,, 0·70 p.c. carbon	£37 10 0	12/6
,, ,, ,, carbon free ..	10½ per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
,, Silicon, 45 p.c. to 50 p.c. ..	£11 10 0 scale 5/– p.u.	
,, ,, 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
,, Vanadium	12/8 per lb.	
,, Molybdenum..	5/6 per lb.	
,, Titanium (carbon free) ..	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, December 27th.

	Home.	Export.
Copper—		
Cash	£32 3 9 to £39 5 0	
Three months	£32 7 6 to £32 8 9	
Electrolytic	£35 10 0 to £36 10 0	
Best Selected Ingots, d/d Birmingham	£36 5 0	
Sheets, Hot Rolled	£62 0 0	
Tubes, Solid Drawn (basis) ..	10d.	10d.
,, Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
,, Brazed	11d.	11d.
Tin—		
Cash	£228 0 0 to £228 2 6	
Three months	£227 17 6 to £228 0 0	
Lead:	£11 5 0 to £11 7 6	
Spelter:	£14 15 0 to £14 18 9	
Aluminium Ingots (British).. ..	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	13/– to 13/6
,, Glasgow— Ell	13/– to 15/6
,, ,, Splint	16/6
Ayrshire	
(f.o.b. Ports)—Steam	13/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	14/6 to 14/9
Unscreened Navigation	12/6 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime..	14/– to 14/6
Secondary Steam	13/6 to 13/9

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke..	13/– to 17/6
Northumberland, Newcastle—	
Blyth Best	14/6 to 15/–
,, Second..	13/–
,, Best Small	10/6 to 11/–
Unscreened	12/– to 12/6
Durham—	
Best Gas..	14/8
Foundry Coke	17/– to 19/–

Sheffield—	Inland.	
Best Hand-picked Branch ..	27/– to 28/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds ..	17/6 to 19/6	—
Rough Slacks..	6/– to 9/–	—
Nutty Slacks	7/– to 8/6	—
Furnace Coke (at ovens)		12/3

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	21/– to 36/–
Furnace Coke	18/6 to 20/–
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles..	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm..	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon
Furnace Oil (0·950 gravity)..	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Commercial Treaties.

The year closes with a general desire to save the industrial situation by re-opening foreign markets. This solution is not so obvious as it appears, in view of the policy that has been pursued all along of making the country self-supporting by monopolising the home market and developing colonial trade in the hope that manufacturers would be able to tide over the period of world economic adjustment. The danger of this attitude is revealed by the fact that the heavy contraction of exports has lessened the country's wealth and helped to check public and private enterprise. Since the Colonies are now recognised as being complementary to foreign markets and cannot be substituted for them, the position is in appearance aggravated. During the first eleven months of the year the value of manufactured goods sent to the Colonies was 3770 million francs out of an export total of 6772 millions, which means that colonial purchases have retrograded at the same time that foreign trade has fallen to a disquieting level. The imports of produce from the Colonies far exceeded those from other countries. It is therefore comprehensible that colonial interests should influence negotiations for commercial arrangements, which are further complicated by the high level of production costs in this country as compared with those elsewhere. It is clear that if commercial negotiations are to be carried to a successful issue some sacrifices must be made for the common good. They will necessarily be long and arduous. The negotiations with Germany for a new commercial treaty have broken down, partly through the desire of the French to reduce import quotas. Every effort will be made in the coming twelvemonth to carry through commercial negotiations, and there is fair promise that, if the financial situation is placed on a firm basis and facilities are offered for foreign exchanges, industrial activity will revive.

Railway Rolling Stock.

Where so much depends upon State expenditure the situation becomes precarious when, as at present, the State has to enforce a rigid policy of economy, and in all departments there are cuts that will affect engineering industries. The sum of 2500 million francs originally arranged to be spent on railway works during 1934 has been reduced by 500 millions. Of the amount allotted by the Superior Railway Council, 233 millions will be devoted to the construction of new lines, 498 millions are set apart for the purchase of rolling stock, and 319 millions for maintenance of locomotives and wagons, while 180 millions will be utilised for the construction of rail cars. Private builders complain that most of the orders for rolling stock will go to the railway companies' own works and that what is left for specialised firms will be wholly insufficient to provide them with even moderate employment. There are better prospects for rail makers in view of the reported intention of the railway companies to employ rails of 62 kilos. to the metre on all the heavy traffic lines. For some time past there has been a controversy over rail breakages, which were at first attributed to the running of heavy locomotives, though it is now affirmed that the trouble has been traced to defective wheel tires, which put abnormal stresses on the rails when braking.

Shipping.

A report issued by the Ministry of Merchant Marine on the situation of shipping at the beginning of 1933 shows that the number of ships at that date was 2419, representing a tonnage of 3,391,303, as compared with 2110 ships and 1,994,402 tons in 1914. The total tonnage of sailing ships fell during the same period from 561,373 to 92,586. There are sixteen shipyards with eighty-five stocks, of which seven can construct ships of between 180 m. and 250 m. long and one of more than 300 m. During the past year the situation of shipping was extremely critical, for at the beginning of January there were only eight ships on the stocks, representing a tonnage of 21,000, and on July 1st there were six vessels totalling 5000 tons. Nevertheless, shipbuilders are confident that the crisis is coming to an end and that a revival of international trade will bring orders to shipyards.

A Wilbur Wright Anniversary.

The town of Le Mans celebrated on Monday of last week the twenty-fifth anniversary of the first long-distance flight by Wilbur Wright, when he covered 99·8 kiloms. in 1 h. 54 min. after he had, a few hours previously, made another record by attaining the altitude of 115 m. He had begun his experiments on August 8th, 1908, on the racecourse near Le Mans, when the machine was launched from rails by a catapult. Wilbur Wright is said to have attached little importance to the aeroplane other than for military purposes, and he explained his preference for the catapult by saying that if the machine landed behind the lines of an enemy they would not be able to use it themselves. It was when passengers were carried, including the late Monsieur Paul Painlevé, that the commercial possibilities of the aeroplane were recognised. The initial flight on August 8th was the first that Wilbur Wright flew in public, for his experiments at Kitty Hawk had been carried out with great secrecy. It is interesting to recall that the Wright biplane had a width across the planes of 40ft. It had two propellers turning at 400 revolutions per minute and driven by a four-cylinder engine of 27 horse-power.

Rail and Road.

A significant step has been taken by the Minister of Public Works in transferring roads from the services that have hitherto controlled them to the State Railway Department, on the plea that the solution of the road problem can only be reached by reference to the conditions of railway working. Lorries are, says the Minister, auxiliaries of the railways and must connect up with them, and traffic on roads that follow or cross railways cannot be carried on except in conjunction with the railways.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

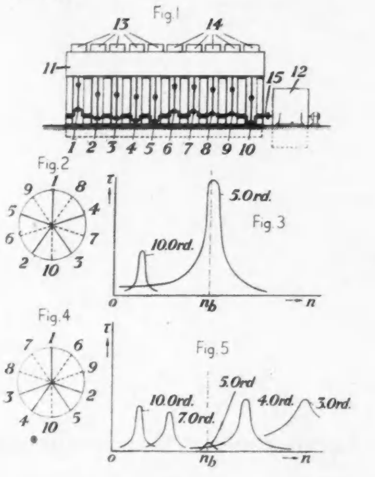
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

401,624. July 31st, 1933.—Ten-cylinder Engines, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

The inventors aim to reduce the internal cyclic stresses in the crank shafts of ten-cylinder, two-stroke engines caused by the firing of the individual cylinders. The wording of the specification is devised to cover a certain arrangement of the cranks of one group of five in relation to the other five, but the essential idea is to destroy any resonance in the shaft with the usual arrangement, illustrated by Fig. 2, in which the engine is divided symmetrically, as regards the length of the crank shaft, in the sequence of firing, and large torsional oscillations of the fifth order are produced, as shown in Fig. 3. With the inventors' arrangement the firing impulses follow one another as indicated in Fig. 4, so that, in a way, the cylinders are out of step and the oscillations are reduced to those shown in Fig. 5.—*November 16th*, 1933.

Nº401,624

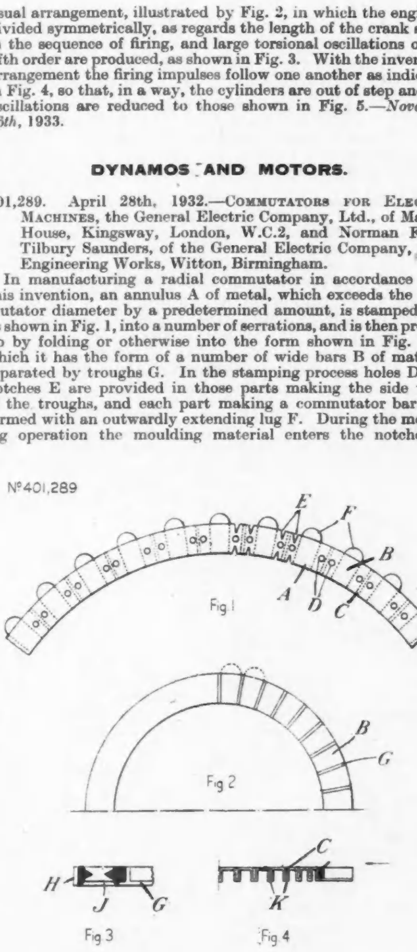


DYNAMOS AND MOTORS.

401,289. April 28th, 1932.—Commutators for Electric Machines, the General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Norman Frank Tilbury Saunders, of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

In manufacturing a radial commutator in accordance with this invention, an annulus A of metal, which exceeds the commutator diameter by a predetermined amount, is stamped out, as shown in Fig. 1, into a number of serrations, and is then pressed up by folding or otherwise into the form shown in Fig. 2, in which it has the form of a number of wide bars B of material separated by troughs G. In the stamping process holes D and notches E are provided in those parts making the side walls of the troughs, and each part making a commutator bar B is formed with an outwardly extending lug F. During the moulding operation the moulding material enters the notches E or/and holes D, whereby the bars are strongly held in place. Adjacent limbs of neighbouring bars may be separated by mica, or the moulding material may be relied upon to insulate the segments from one another. During the moulding operation the ring A formed with corrugations is placed between and spaced from an inner supporting ring G and an outer strengthening ring H, Fig. 3. The moulding material is then moulded into the space between the rings and into the spaces between the limbs of the commutator bars. The inner ring G may form part of a spider and the rings may be flanged, notched, or formed with lugs, so that the insulating material is strongly held thereto. After the moulding material has formed a solid mass, the under surface J of the serrated disc is machined down until the metal forming the bottom walls K of the troughs is cut away, thus open-circuiting each commutator bar B.—*October 30th*, 1933.

Nº401,289

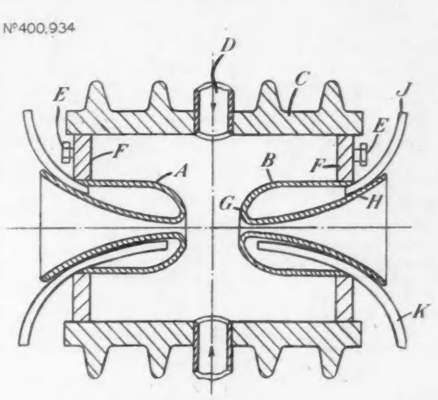


ELECTRICAL APPLIANCES.

400,934. February 23rd, 1932.—Conversion of Electric Currents, Dr. Ing. Erwin Marx, of Rankestrasse 3, Baunschweig, Germany.

Electrodes for a spark gap rectifier suitable for power circuits are described in this specification. The electrodes A and B are fitted into a pressure chamber C of insulating material. Compressed air or other gas is introduced at D and flows out through the nozzle-shaped orifices in the electrodes. E represent the line connection terminals on the plates F by which the electrodes are carried. If a flashover is provoked between A and B by a transient high voltage, ignition of the arc takes place between two closely opposing points of the electrodes, and immediately after ignition the arc, owing to the current of air, travels from the ignition point towards the wide nozzle outlet, viz., for instance, from point G to point H of the electrode B. Owing to the double-sided blow-out action, the arc is, in this case, lengthened to an unusual extent and ruptures with certainty when the current passes through zero, as when alternating current rectification is being performed. The re-establishment of the arc is prevented as there are no longer any free electrons present in the vicinity of the electrodes owing to the current of air. High-efficiency rectification can be obtained by this arrangement. Cooling fluid is supplied through the pipes J, K.—*October 23rd*, 1933.

Nº400,934

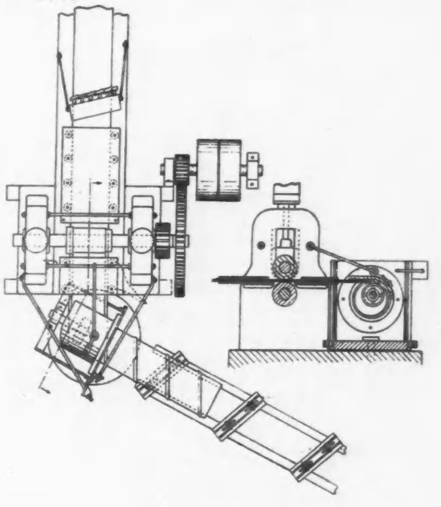


MACHINE TOOLS AND SHOP APPLIANCES.

401,139. January 30th, 1933.—Making Steel Pipes, A. G. H. Ferguson and M. J. Ferguson, Gordon-street, Footscray, Victoria, Australia.

Steel pipe is made, according to this invention, by pushing strip tangentially into a die to form a helix and then welding the joints. In passing through the feed rolls the edges of the strip are bent so that it wraps together with a spigot and socket effect. The making machine is illustrated by the drawings, but the welding apparatus is not shown. A feature of the system is the entrance portion of the die, which gives to the strip a sharper curvature than that necessary for the ultimate diameter of the pipe, so that the steel may recover from its elasticity without pressing unduly on the interior of the die.—*November 9th*, 1933.

Nº401,139

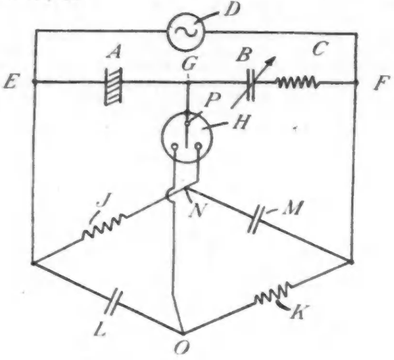


MEASURING AND TESTING INSTRUMENTS.

401,488. October 26th, 1932.—Electrical Measuring Circuits and Apparatus, the British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2, and George Rupert Ridpath Bray, of 86, Dunchurch-road, Rugby, and Kenneth James Rawcliffe Wilkinson, of 16, Vernon-avenue, Hillmorton Paddox, Rugby.

The apparatus described in this specification is particularly applicable to the measurement of power factor or loss angle of samples of insulating materials. An approximate measure of these values may be obtained very quickly where a high standard of accuracy is not required—for example, in manufacturing shop tests. The terminals of the condenser A made up with the sample dielectric are connected in series with a standard condenser B and resistance C, one or both of which may be variable. An alternating supply D is connected across the extreme terminals E F. If the power factors of the sample A and of the circuit comprising condenser B and C are equal, the potential differences between their junction G and their extreme terminals E and F will be in the same phase. To test this, a circuit comprising the symmetrical electrometer H is employed. A voltage for the fixed electrodes of this electrometer may be obtained by a bridge circuit made up of two resistances J, K, and two condensers L, M, all of equal impedance and connected as shown. The voltages at E N, E O, F N, F O will all be equal in amplitude. The fixed electrodes of the electrometer are connected across N O, and the correctness of the bridge may be checked by connecting the moving electrode P to E and to F in succession when there should be no deflection. If, then, P is connected to the junction G, and if the power factor of G F is adjusted by varying the capacity H and resistance C until the electrometer gives a central reading, then the potential differences at E G, G F, E F are in the same phase and the power factor of G F is the same as that of E G, or the sample A.—*November 16th*, 1933.

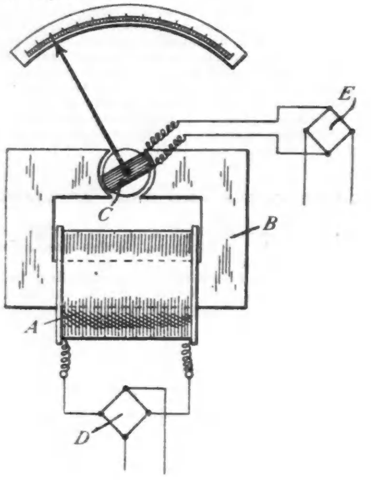
Nº401,488



401,277. May 7th, 1932.—Alternating Current Electrical Instruments, Elliott Brothers (London), Ltd., of Century Works, Lewisham, Kent, and George Frederick Shotter, of 14, The Ridgeway, Friern Barnet.

The instrument shown is for measuring volt ampères in a single-phase system. A is the voltage winding wound on a copper spool surrounding a magnetic core B of substantially horse-shoe form. A coil C is suspended or pivoted to move in the space between the poles. The voltage winding A is connected to rectifying apparatus D connected, in turn, across the supply, and similarly the coil C which constitutes a current coil is connected to rectifying apparatus E, which is connected in series with the supply. A polyphase instrument and a modification of the invention are also described.—*November 7th*, 1933.

Nº401,277

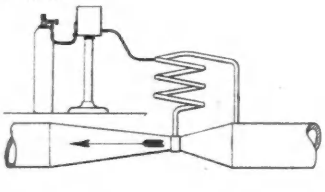


WATER PURIFICATION.

401,589. April 18th, 1933.—Chlorinating Apparatus, G. D. Peet, 11, Mill-street, Belleville, Essex County, New Jersey.

The inventor explains that in the sterilisation of water by means of chlorine there is the possibility of trouble through the production of chlorine hydrate if the added solution is of too strong a concentration. A pump is generally used to provide the water for making the solution, and, as a consequence, there is a tendency to reduce this flow as much as possible. The inventor, however, uses the pressure difference of a Venturi tube that requires no attendance to produce a copious auxiliary flow into which the chlorine gas is introduced.—*November 16th*, 1933.

Nº401,589

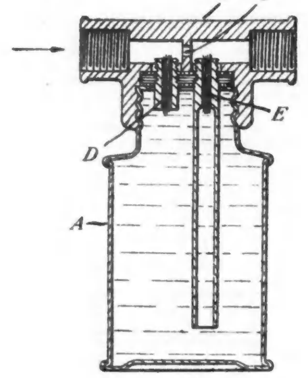


MISCELLANEOUS.

401,126. December 16th, 1932.—Lubricating Internal Combustion Engines, Tecalemit, Ltd., Great West-road, Brentford, Middlesex.

This invention is concerned with the addition of oil to the combustible mixture of internal combustion engines for lubricating purposes. An oil container A is attached to a fitting B on the induction pipe. This fitting has a restricting orifice C and two wicks D and E dipping into the oil. The excess pressure on the wick D at the inlet side is then transmitted to the wick E through the oil, thus adding a pressure effect to the capillary action, facilitating the flow of oil into the fuel pipe. The flow of oil will be proportional to the difference of pressure. It will also be noted that in accordance with the reduction of the quantity of oil in the reservoir, the viscosity of the mixture of oil and fuel will diminish, and that consequently the flow through the wick E will increase. Thus, the decrease of the amount of oil in the mixture drawn through the wick will be automatically compensated, whilst the proportion of oil with respect to the fuel in the pipe at the inlet side of the apparatus will remain constant.—*November 9th*, 1933.

Nº401,126



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Saturday, December 30th.

Royal Inst. of Great Britain.—21, Albemarle Street, W.1. Christmas Juvenile Lectures. "Through Space and Time: II., Moon and Planets," Sir James Jeans. 3 p.m.

1934.

Tuesday, January 2nd.

Inst. of Automobile Engineers.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.45 p.m.

Wednesday, January 3rd.

Inst. of Electrical Engineers: Wireless Section.—Savoy-place, W.C.2. "An Investigation into the Factors Controlling the Economic Design of Beam Arrays," Mr. T. Walmsley. 6 p.m.

Thursday, January 4th.

Inst. of Automobile Engineers.—Queen's Hotel, Birmingham. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 8 p.m.

Inst. of Metals: Birmingham Local Section.—James Watt Memorial Inst., Birmingham. "Nickel and Nickel Alloys," Mr. W. R. Barclay. 7 p.m.

Friday, January 5th.

Inst. of Sanitary Engineers.—Caxton Hall, S.W.1. Presidential address, Mr. Godfrey M. C. Taylor. 6 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Reproduction of Engineering Drawings," Mr. G. V. Rickards. 7.30 p.m.

Saturday, January 6th.

Sheffield Metallurgical Assoc.—198, West-street, Sheffield. Club dance. 7.30 to 11 p.m.

Monday, January 8th.

Electrodepositors' Technical Soc.: Midland Centre.—James Watt Memorial Inst., Birmingham, 3. "Electrodeposition for Wear Resistance," Dr. J. Kronsbein. 7.30 p.m.

Inst. of Chemical Engineers.—Joint meeting with Soc. of Chemical Industry. In Rooms of Chemical Soc., Burlington House, W.1. "Legal Pitfalls for the Chemical Engineer," Mr. J. D. Pratt and Mr. G. S. W. Marlow. 6 p.m.

Inst. of Transport.—London meeting. "The 'Royal Scot' in Canada and the U.S.A.," Mr. E. J. H. Lemon.

Stephenson Locomotive Soc.—King's Cross Station, N.1. "The Railways of Switzerland over Mountain and Plain," Mr. R. A. H. Waight. 6.30 p.m.

Tuesday, January 9th.

Inst. of Automobile Engineers.—King's Head Hotel, Coventry. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.30 p.m.

Inst. of Marine Engineers.—85–88, The Minories, E.C.3. "Steels in Marine Engineering Service," Mr. T. H. Burnham. 6 p.m.

Inst. of Metals: N.E. Coast Local Section.—Armstrong College, Newcastle-upon-Tyne. "Physical Properties of Deposited Weld Metal in the Arc-welding and Atomic Hydrogen Processes," Messrs. C. R. Deglon and L. Miller. 7.30 p.m.

Inst. of Transport: Birmingham and District Meeting. "Transport and Decentralisation," Sir Herbert Austin.

Sheffield Metallurgical Assoc.—198, West-street, Sheffield. Annual general meeting. 7.30 p.m.

Tuesday to Thursday, January 9th to 11th.

Physical Society.—At Imperial College of Science and Technology, S. Kensington, S.W.7. Exhibition. Open 3 p.m. Discourse, "Evolution of the Galvanometer," Mr. R. S. Whipple, at 8 p.m. Wednesday: Open 4 p.m., discourse, "Instrumental Side of Calorimetry," Mr. J. Guild, at 8 p.m. —Thursday: Open 3 p.m., discourse, "History and Development of the Thermionic Valve," Sir J. Ambrose Fleming, F.R.S., at 8 p.m.

Wednesday, January 10th.

Soc. of Glass Technology: London Section.—At Offices of Holophane, Ltd., Elverton-street, Westminster, S.W.1. "Some Modern Uses of Glass," Mr. G. Novell. 7.30 p.m.

Thursday, January 11th.

Inst. of Automobile Engineers.—At Merchant Venturers' Technical College, Bristol. "Development of a Constant-Periodicity Suspension System," Mr. S. A. Horstmann. 7 p.m.

Inst. of Marine Engineers: Junior Section.—85–88, The Minories, E.C.3. "Stern Tubes and Tail-end Bearings," Mr. A. C. West. 7 p.m.

Inst. of Metals: London Local Section.—At Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "Beryllium and its Alloys," Mr. H. A. Sloman. 7.30 p.m.

Royal Aeronautical Soc.—Lecture postponed.

Friday, January 12th.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Mr. B. D. Parritt will introduce discussion on "Rubber and its Engineering Uses." 7 p.m.

Inst. of Metals: Sheffield Local Section.—The University, Sheffield. "Protection from Corrosion of Aluminium and its Alloys," Mr. N. D. Pullen. 7.30 p.m.

Inst. of Transport: Newcastle-upon-Tyne and District Section.—"Future Developments in Air Transport," Mr. W. L. Runciman.

Railway Club.—57, Fetter-lane, E.C.4. "Why the L. and N.W. Railway was the Premier Line," Mr. J. D. Godfrey. 7.30 p.m.

Saturday, January 13th.

Inst. of Marine Engineers: Junior Section.—Social and dance. 7.30 p.m. to 11.15 p.m.

Monday, January 15th.

Inst. of Automobile Engineers.—At Inst. of Engineers and Shipbuilders, 39, Elmbank-crescent, Glasgow. "Development of a Constant-Periodicity Suspension System," Mr. S. A. Horstmann. 7.30 p.m.

Inst. of Metals: Scottish Local Section.—39, Elmbank-crescent, Glasgow. "Factors in the Solidification of Molten Metals," Dr. Sydney W. Smith. 7.30 p.m.

Tuesday, January 16th.

Institutions of Mechanical and Electrical Engineers: Graduate and Student Sections and London Students of Civil Engineering.—Joint Dance at Victoria Halls. 7.30 p.m.

Inst. of Metals: Birmingham Local Section.—James Watt Memorial Inst., Birmingham. "Electric Welding," Mr. C. A. Hadley. 7 p.m.

Inst. of Transport.—London meeting. "The British Coasting Trade and its National Importance," Mr. J. R. Cowper.

Wednesday, January 17th.

Inst. of Automobile Engineers.—Metropole Hotel, King-street, Leeds. "Repairs," Mr. J. Dent. 7.15 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "Modern Developments in Street Lighting," Mr. J. M. Waldram. 8 p.m.

Thursday, January 18th.

Inst. of Structural Engineers: Yorkshire Branch.—Hotel Metropole, Leeds. "The London Building Act of 1930 and its Effect on Structural Design," Mr. W. C. Cocking. 7 p.m.

Liverpool Engineering Soc.—Adelphi Hotel, Liverpool. Annual dinner. 7 p.m. for 7.30 p.m.

Friday, January 19th.

University of London.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

Tuesday, January 23rd.

Stephenson Locomotive Soc.: Scottish Branch.—Royal Technical College, Glasgow. "Some Railway Travels," illustrated by lantern. Mr. John McInnes. 7.45 p.m.

Wednesday, January 24th.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "Modern International Practice in Factory Design," Mr. Hal Williams. 8 p.m.

Friday, January 26th.

University of London.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

Tuesday, January 30th.

Inst. of Transport.—London, informal meeting. Discussion, "Traffic Light Control Signals," opener, Mr. J. S. Pool

END OF VOL. CLVI.

Printed on Thin Paper for Foreign Circulation.

With METALLURGICAL SUPPLEMENT.

The Engineer.

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VOL. CLVI.—No. 4068]

LONDON: FRIDAY, DECEMBER 29, 1933

[PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

Borough of Reigate.
ELECTRICITY DEPARTMENT.
OFFERS are INVITED for the SALE by the Corporation of the following PLANT:—

Two 150 B.H.P. Three-cylinder Carels Diesel Engines, coupled direct to 2500-Volt Single-phase 50 Cycles E.C.C. Alternators and Exciters.

The plant can be inspected by appointment at the Corporation's Generating Station, Wray Common-road, Reigate.

Offers, endorsed "Tender for Plant," must be delivered to the Town Clerk, Municipal Buildings, Reigate, not later than Wednesday, the 10th January, 1934.

The highest or any Offer will not necessarily be accepted.

HEBER DAVIES,
Town Clerk.

Municipal Buildings, Reigate,
18th December, 1933. 1387

County Borough of Brighton.
WATERWORKS DEPARTMENT.
BALSDEAN SUPPLY.
TO MAIN-LAYING CONTRACTORS.
The Corporation are prepared to receive TENDERS for CARTING, LAYING and JOINTING about 4026 Yards of 20in., 360 Yards of 15in., and Short Lengths of 8in. and 3in. SPUN IRON PIPES, together with the necessary Valves and Specials.

Copies of the general conditions of contract, specification, bill of quantities, and form of Tender, may be obtained upon application to the Waterworks Engineer, Mr. A. B. Cathcart, M. Inst. C.E., M.I. Mech. E., 12, Bond-street, Brighton, and enclosing a cheque for Two Guineas, which will be refunded upon receipt of a bona fide Tender (not subsequently withdrawn), and the return of the documents. The drawings may also be inspected at the offices of the Waterworks Engineer, as above.

Sealed Tenders, endorsed "Tender for Pipe Laying: Balsdean Main," and addressed to me, must be delivered at my office at the Town Hall, Brighton, by Twelve Noon on Monday, 15th January, 1934.

JAS. H. ROTHWELL,
Town Clerk.

Town Hall, Brighton,
22nd December, 1933. 1386

Midhurst Rural District COUNCIL.
WATERWORKS.
CONTRACT No. 8.
TO CONTRACTORS.
The above Council are prepared to receive TENDERS for the COMPLETE EQUIPMENT of DUPLICATE ELECTRICALLY DRIVEN PUMPING PLANT, of British manufacture, to be installed over two bored wells at Easebourne Pumping Station.

The works included in the contract consist of Two Turbine Pumps, each driven by an electric motor, together with all necessary Electrical Equipment and Connections inside the building, in accordance with drawing, general conditions, and specification prepared by the engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W.1.

Copies of the specification, drawing, and form of Tender may be obtained from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Sealed Tenders, endorsed "Pumping Plant, Contract No. 8," addressed to the undersigned, at his office at Midhurst, must be received before Noon on Monday, the 29th day of January, 1934.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
(Signed) J. M. FURNEAUX,
Clerk to the Council.

Council Offices,
Midhurst,
Sussex. 1385

Metropolitan Borough of POPLAR.
ELECTRICITY UNDERTAKING.
APPOINTMENT OF CHIEF TECHNICAL ASSISTANT.
APPLICATIONS are INVITED from fully qualified persons not more than 36 years of age for the POSITION of CHIEF TECHNICAL ASSISTANT TO THE UNDERTAKING of the Council.

The salary payable will be at the rate of £800 per annum.

Applicants must be conversant with large Power Tariffs, System Change-overs, Organisation of Meter Test and Repair Departments. A knowledge of Scientific Street Lighting will be an advantage. It is essential that candidates be Corporate Members of the Institute of Electrical Engineers.

The person appointed will be required to pass a medical examination, and to contribute to the Council's Superannuation Fund.

Forms of application, with conditions of the appointment, may be obtained from my office upon receipt of a stamped, addressed foolscap envelope, and must be returned so as to reach me not later than 12 Noon on Friday, 19th January, 1934, endorsed "Chief Technical Assistant."

Canvassing, either directly or indirectly, will disqualify.

H. E. DENNIS,
Town Clerk.

Council Offices,
High-street,
Poplar, E.14,
December, 1933. 1393.

Wolverhampton Corporation
WATER UNDERTAKING.
DISTRIBUTION FOREMAN.
APPLICATIONS are INVITED for the POST of DISTRIBUTION FOREMAN at a salary, in accordance with the Corporation's Grading Scheme, of £200 per annum, rising by annual increments of £10 to £230 per annum, together with free house, coal and light, and uniform.

The successful applicant will be required to pass a medical examination, and to pay contributions to the Superannuation Fund.

Applicants must have had considerable experience in similar posts, including the Laying and Repairing of Large Water Mains and the Management of a Depot.

A stamped, addressed foolscap envelope should be sent to the undersigned for full details of the duties and conditions of employment, and a copy of the printed application form, and the applications on the said forms, accompanied by not less than two recent testimonials, must be returned not later than January 15th, 1934.

B. L. McMILLAN, B.Sc., M. Inst. C.E.,
Water Engineer and Manager.

Town Hall,
Wolverhampton,
December 20th, 1933. 1398

The Engineer

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PUBLIC NOTICES.

City of Liverpool.
APPOINTMENT OF WATER ENGINEER.
The Corporation invite APPLICATIONS for the APPOINTMENT of WATER ENGINEER, at a salary of £1750 per annum, rising by annual increments of £50 to £2000 per annum.

The appointment will be subject to the Local Government and Other Officers' Superannuation Act, 1922, and the Standing Orders of the City Council, and will be determinable by three calendar months' notice on either side.

The person appointed will be required to reside within the city or such other place as may be approved by the Council, and to devote his whole time to the duties of the office, and will not be allowed to engage in private practice. He will be required to hand over to the City Treasurer any fees or other amounts received in connection with the appointment as provided by the Standing Orders of the Council. He will also be required to pass a medical examination.

Experience of impounding reservoirs is essential.

Particulars of duties may be obtained on application to the Town Clerk.

Applications, endorsed "Water Engineer," stating age, qualifications and experience, accompanied by copies of three recent testimonials, addressed to the Chairman of the Water Committee under cover to the Town Clerk, Municipal Buildings, Liverpool, must be delivered at the Town Clerk's Office not later than the 9th January, 1934.

Canvassing of members of the City Council, either directly or indirectly, will be considered a disqualification.

Dated this 12th day of December, 1933.

WALTER MOON,
Town Clerk.

Municipal Buildings,
Liverpool, 2. 1357

SITUATIONS OPEN.

CHIEF INSPECTOR REQUIRED for the Midlands, thoroughly accustomed to inspection of motor components, knowledge of latest practice, and accustomed to handling female labour.—Address, 1374, The Engineer Office. 1374 A

PUBLIC NOTICES.

Visiting Committee of the HERTFORDSHIRE COUNTY MENTAL HOSPITAL.
HILL END MENTAL HOSPITAL, NEAR ST. ALBANS, &c.

ENGINEER-IN-CHARGE.

The Visiting Committee of the Hertfordshire County Mental Hospital at Hill End invite APPLICATIONS for the APPOINTMENT of ENGINEER-IN-CHARGE of the Engineering Equipment (including Heating, Water, Sewage, and Electricity) at the Hill End Mental Hospital and the Cell Barnes Mental Deficiency Colony, near St. Albans.

Salary £450 per annum with unfurnished house valued at £50 per annum, such salary (over and above the first £150) for the present being subject to temporary deduction of 5 per centum.

The appointment will be subject to the provisions of the Asylums Officers' Superannuation Act, 1909, for which purpose the successful candidate will be required to pass a medical examination.

Successful applicants must be prepared to enter into an agreement if required.

Candidates must possess experience in the Management of Engineering Equipment in connection with Heating, Water, Sewage, Electricity, and in Repairs and Painting to Buildings, and Organisation and Control of Staff and Workmen, and be prepared to act as Clerk of the Works.

Applications, stating age (which must be between 33 and 40), qualifications, and experience must be submitted on the official form, which can be obtained from the Clerk to the Visiting Committee, Clerk of the Peace Office, Hertford, and must be returned duly completed not later than the Thirtieth day of January, 1934, accompanied by copies (not originals) of not more than three recent testimonials.

Selected applicants will be required to attend before a Committee at Hill End, St. Albans, and reasonable expenses in this connection will be paid.

ELTON LONGMORE,
Clerk to the Visiting Committee.

Clerk of the Peace Office,
Hertford,
23rd December, 1933. 1396

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.
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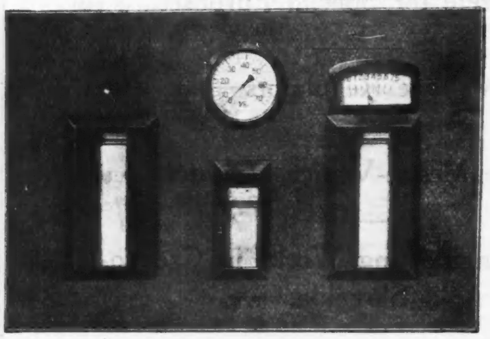

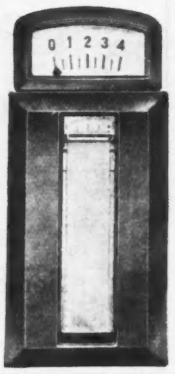

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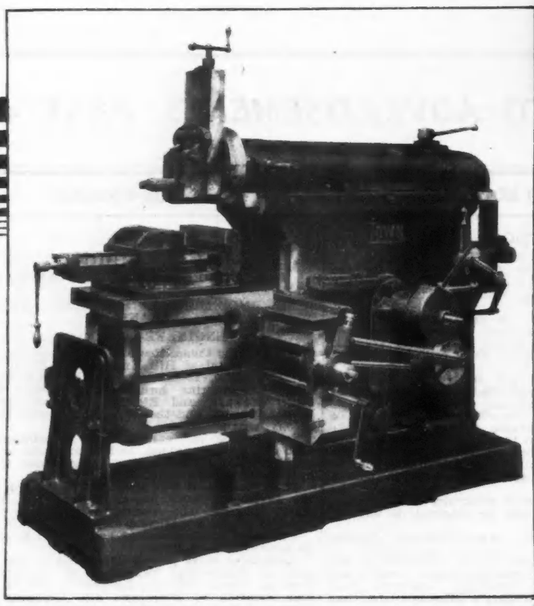

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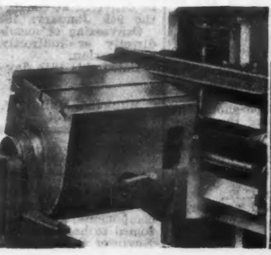

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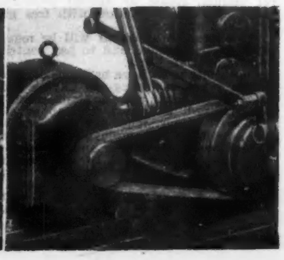

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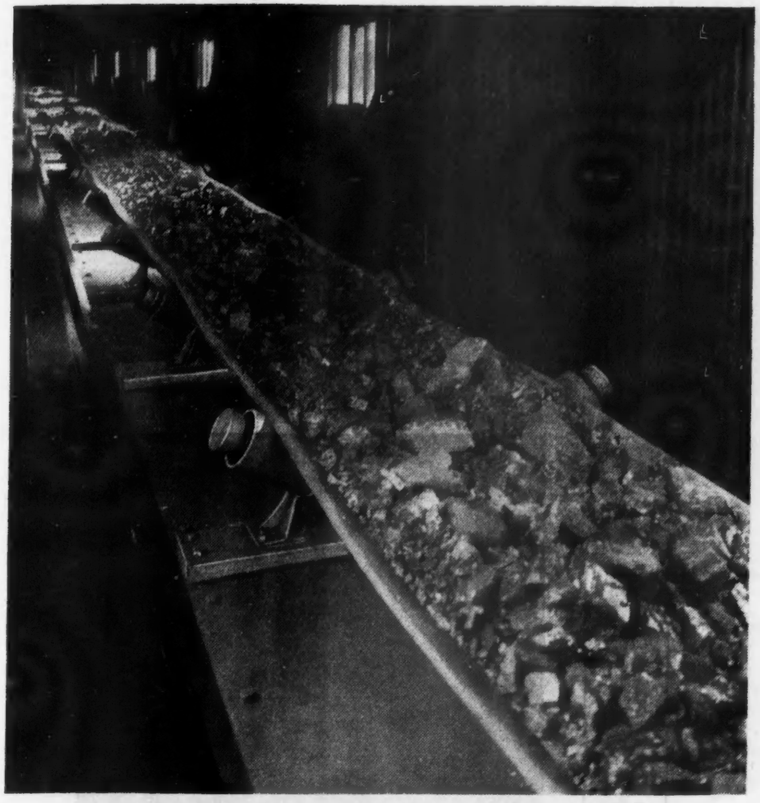

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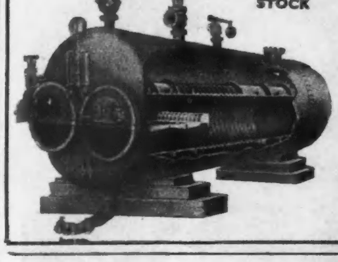

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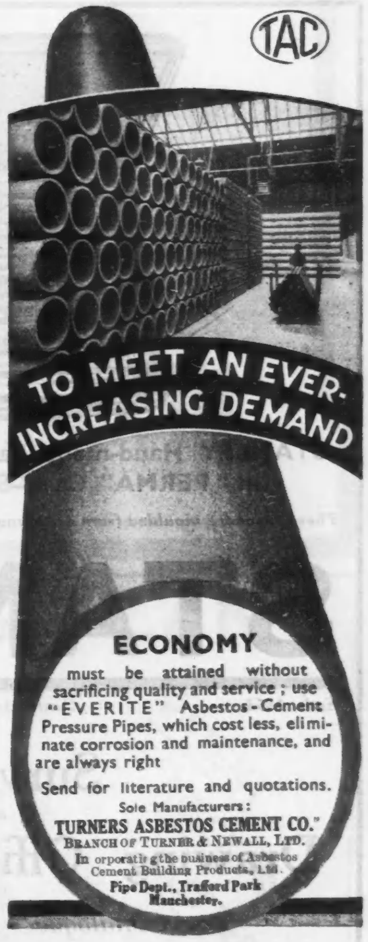

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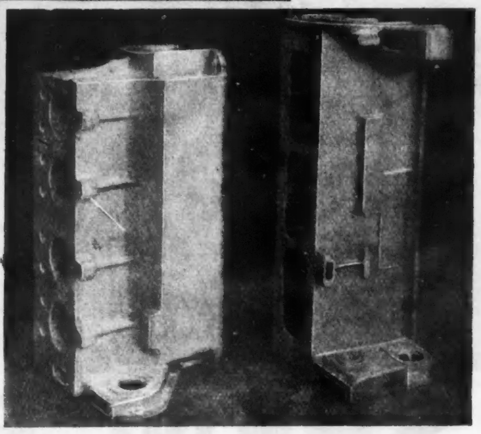

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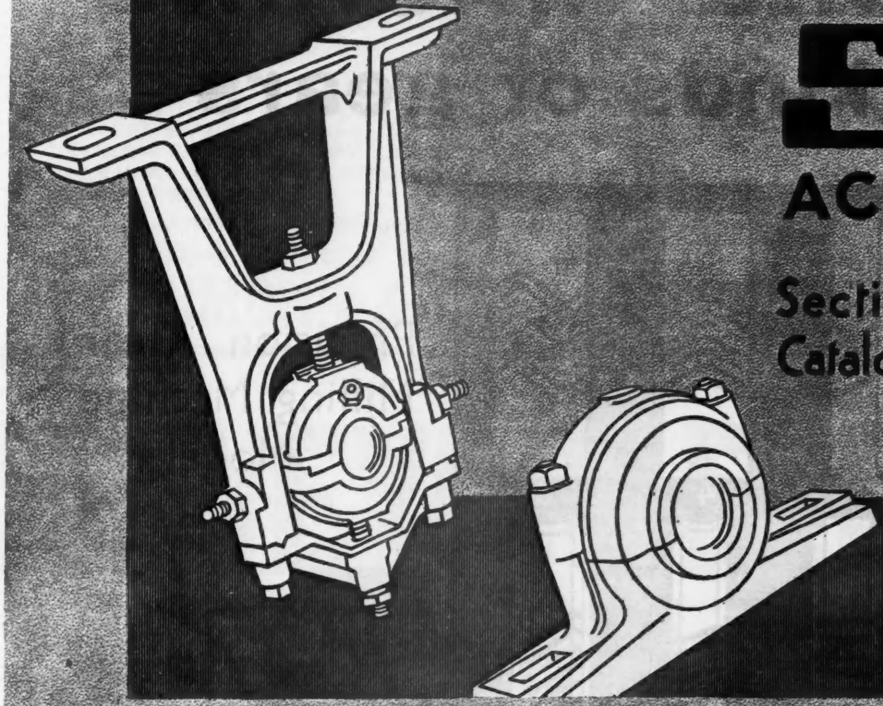

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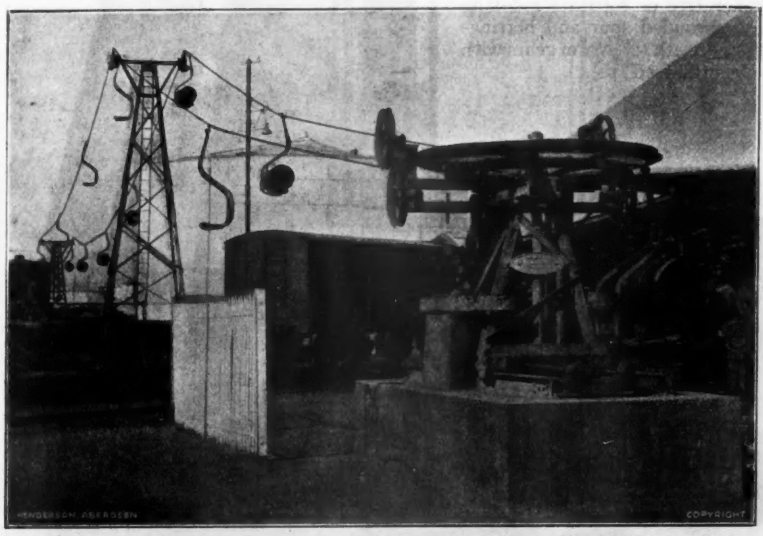

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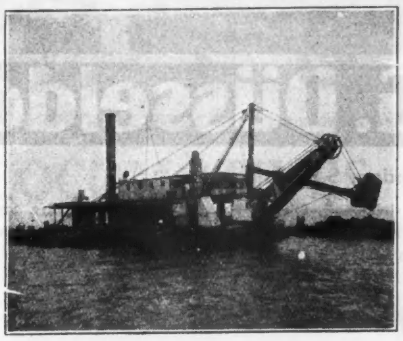

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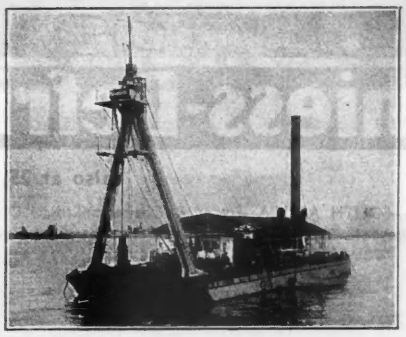

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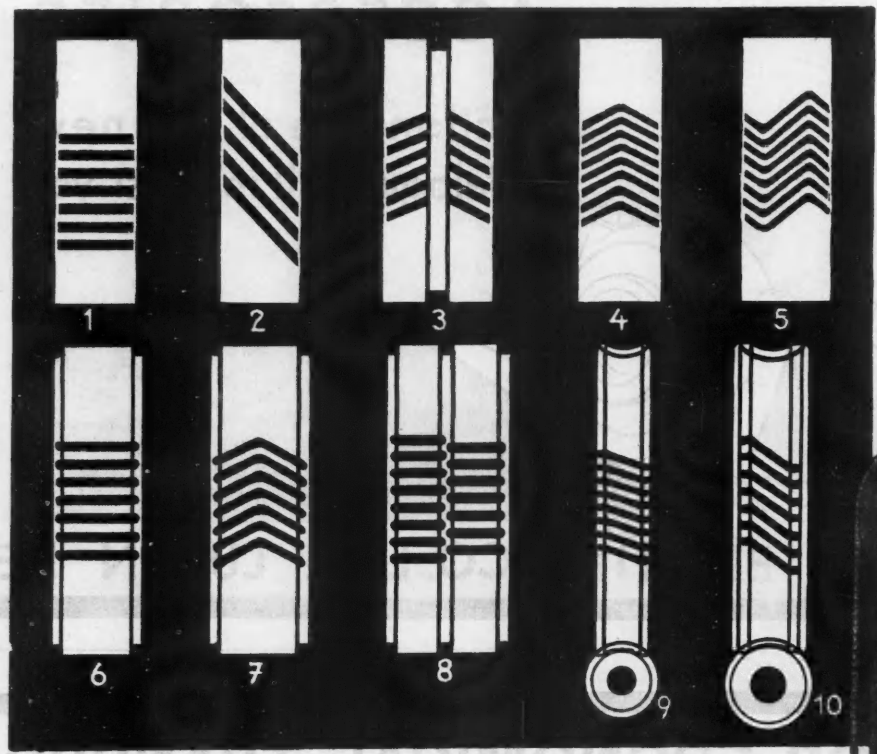

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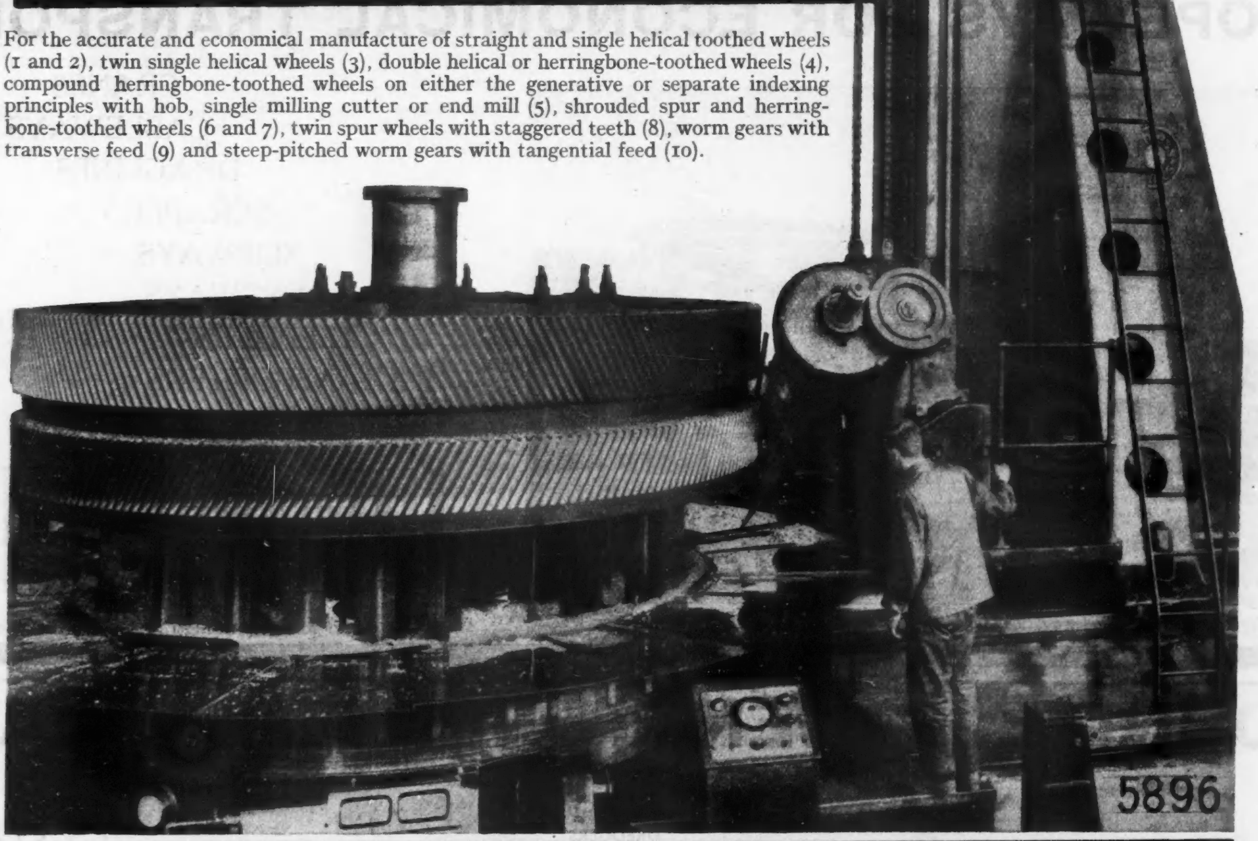

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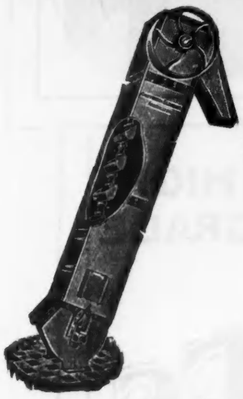

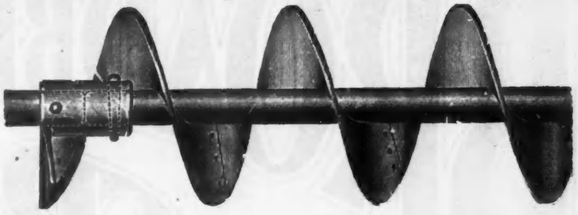

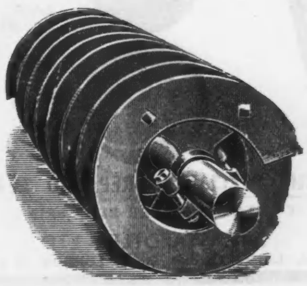

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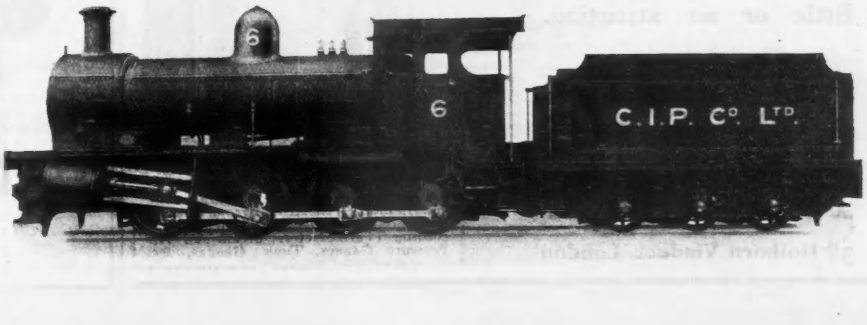

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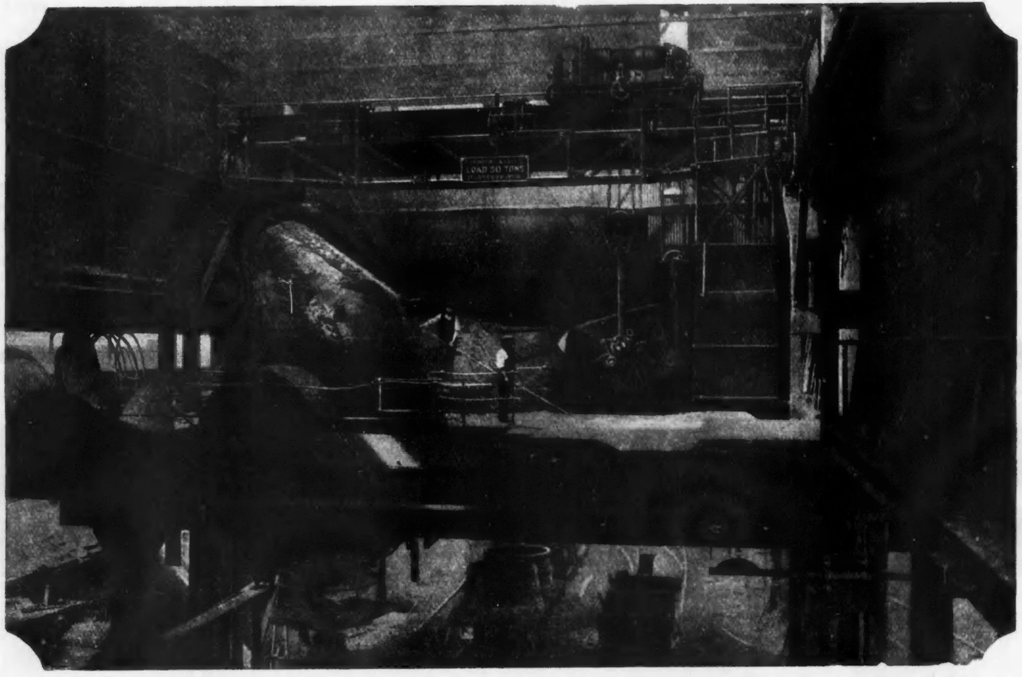

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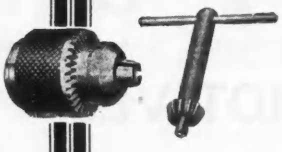

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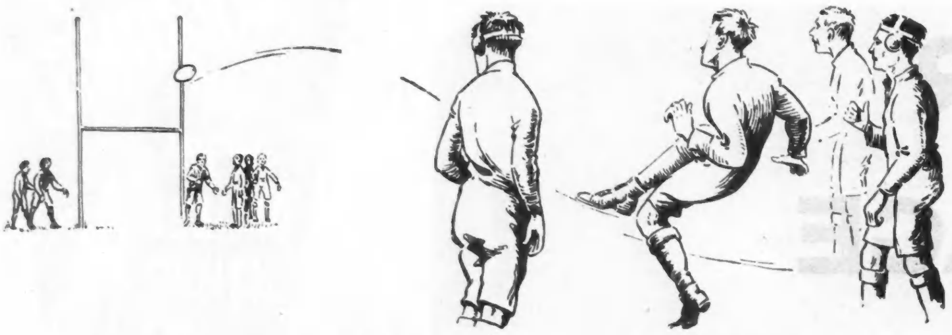

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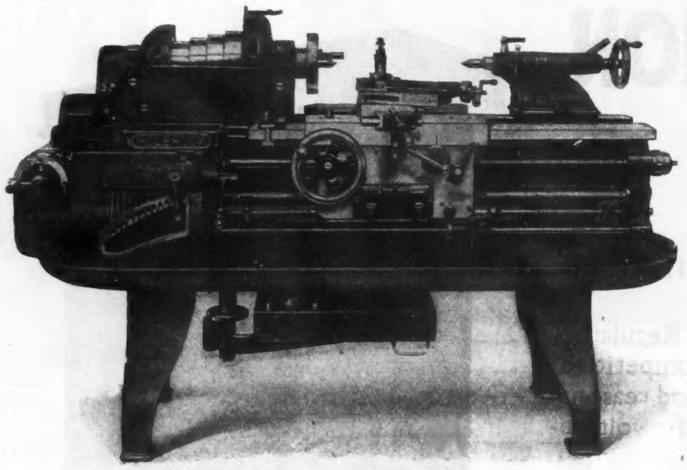

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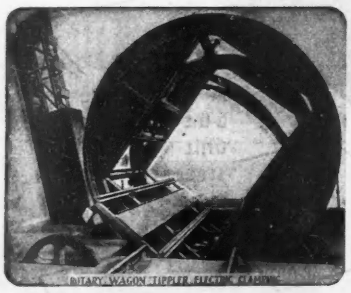

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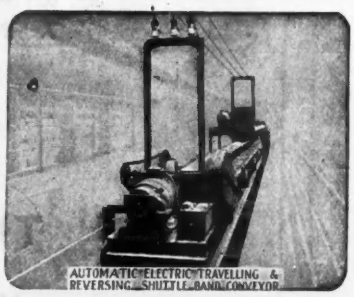

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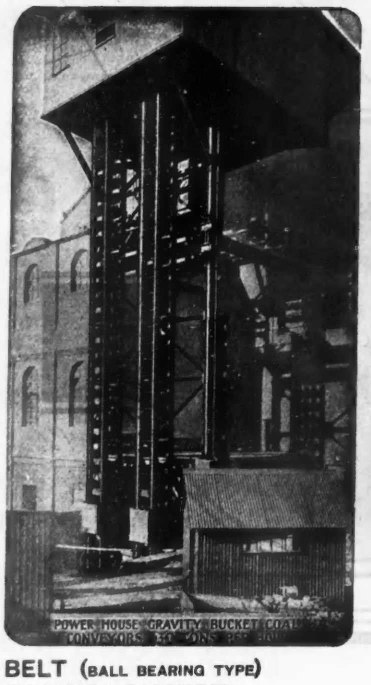

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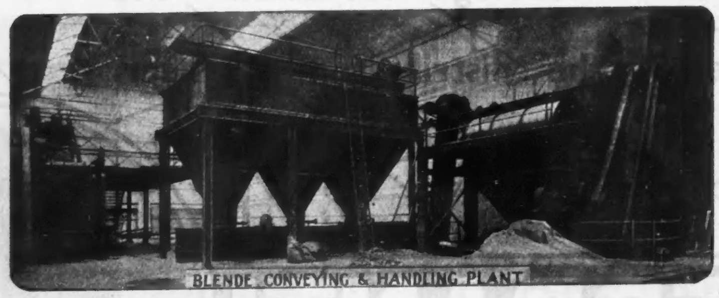

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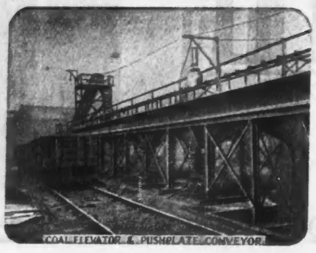

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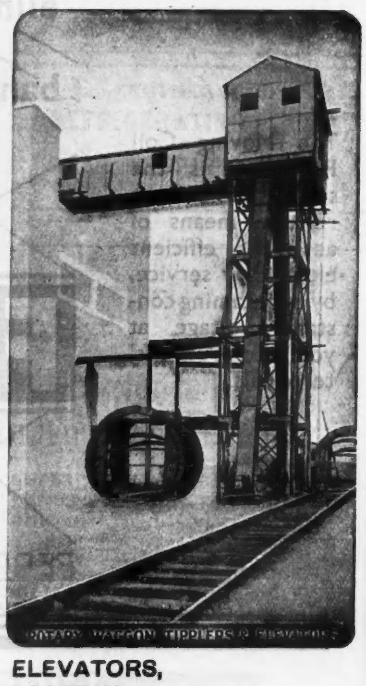

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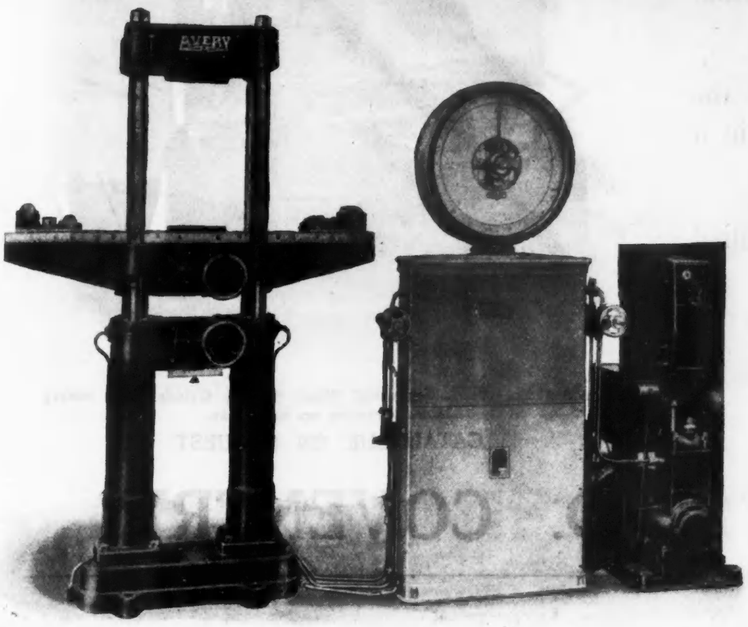

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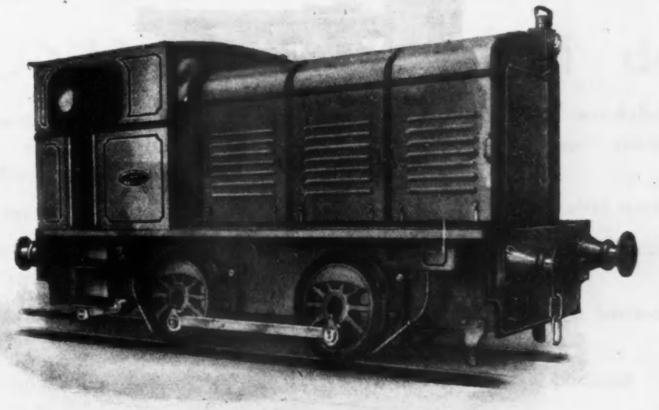

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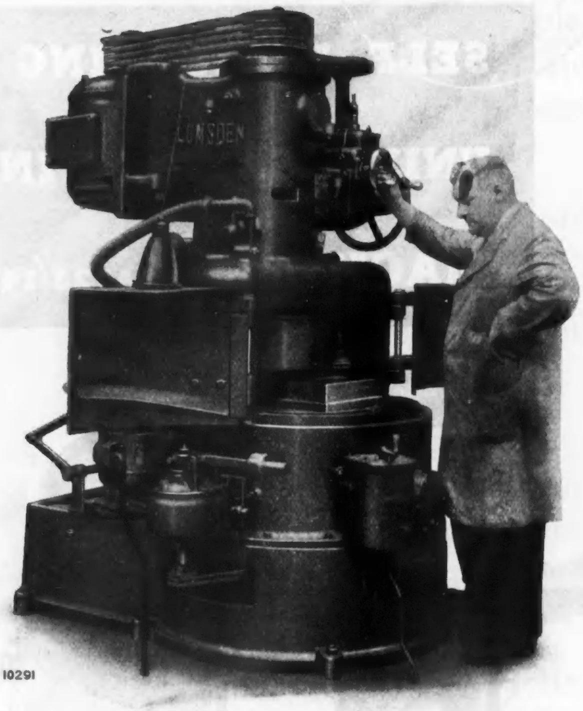

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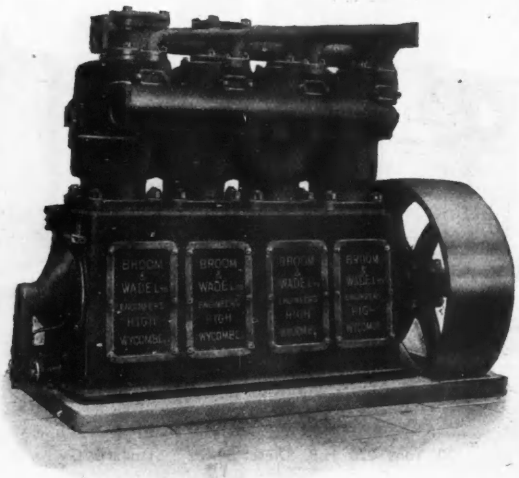

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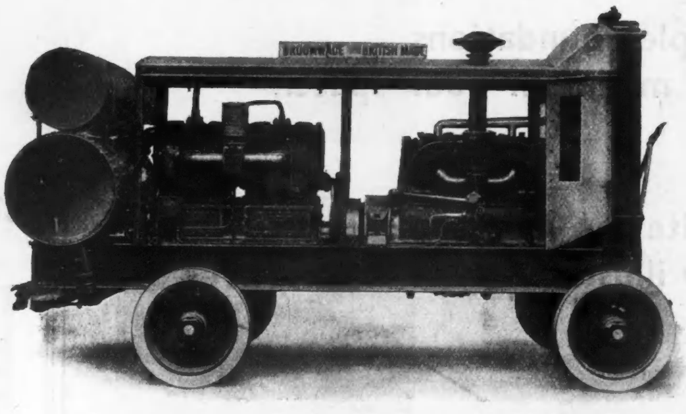

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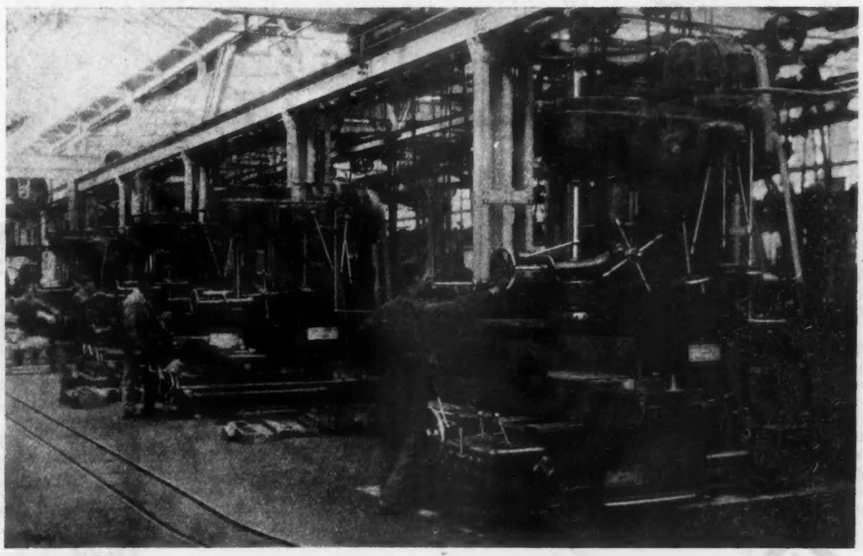

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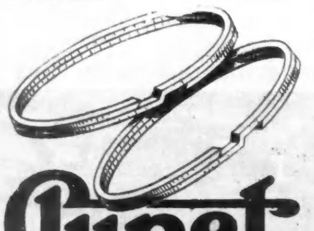

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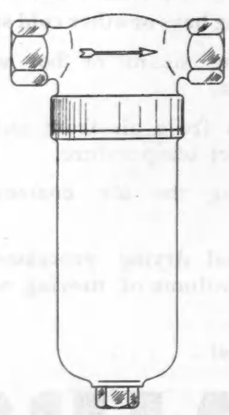

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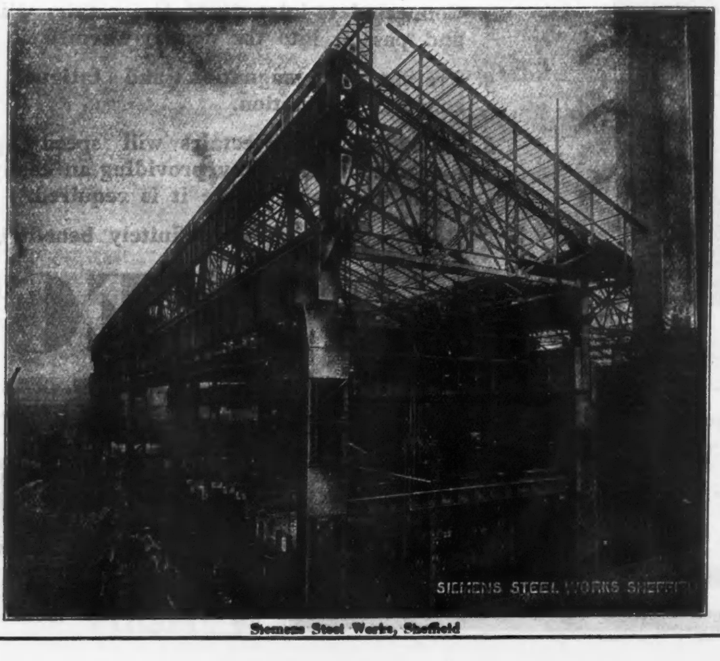
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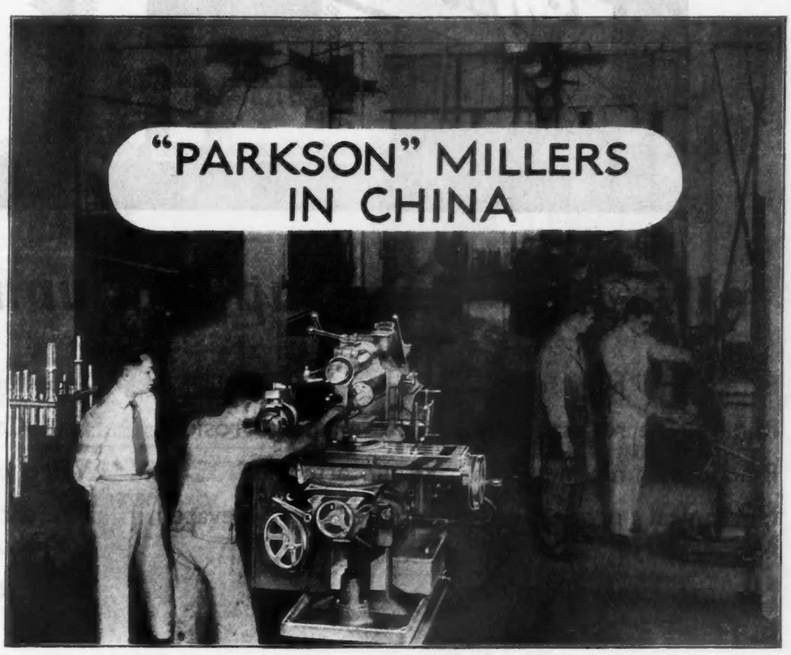

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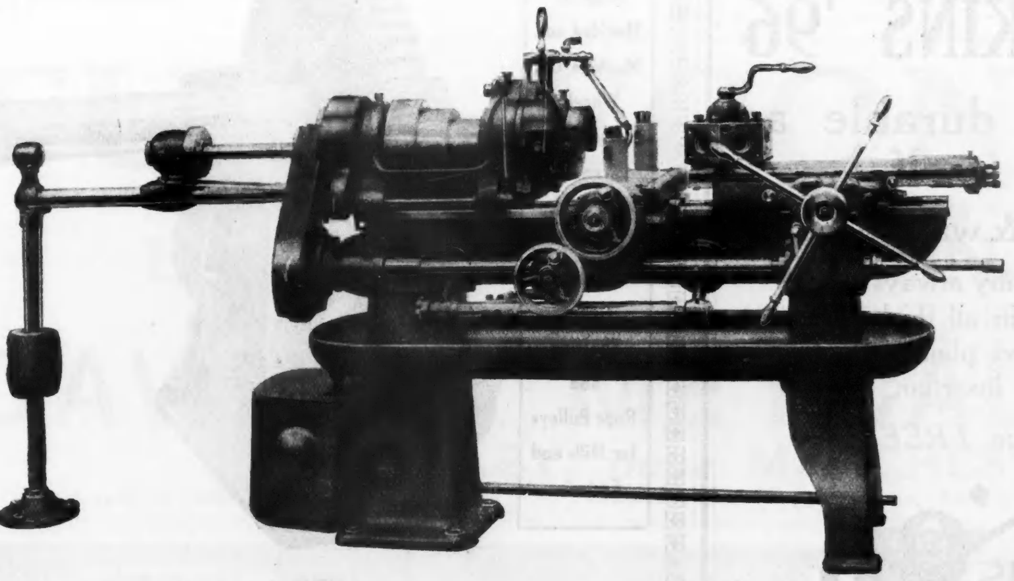

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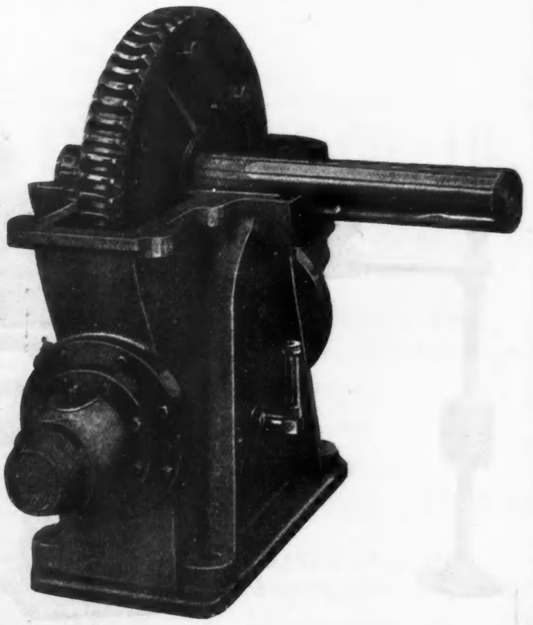

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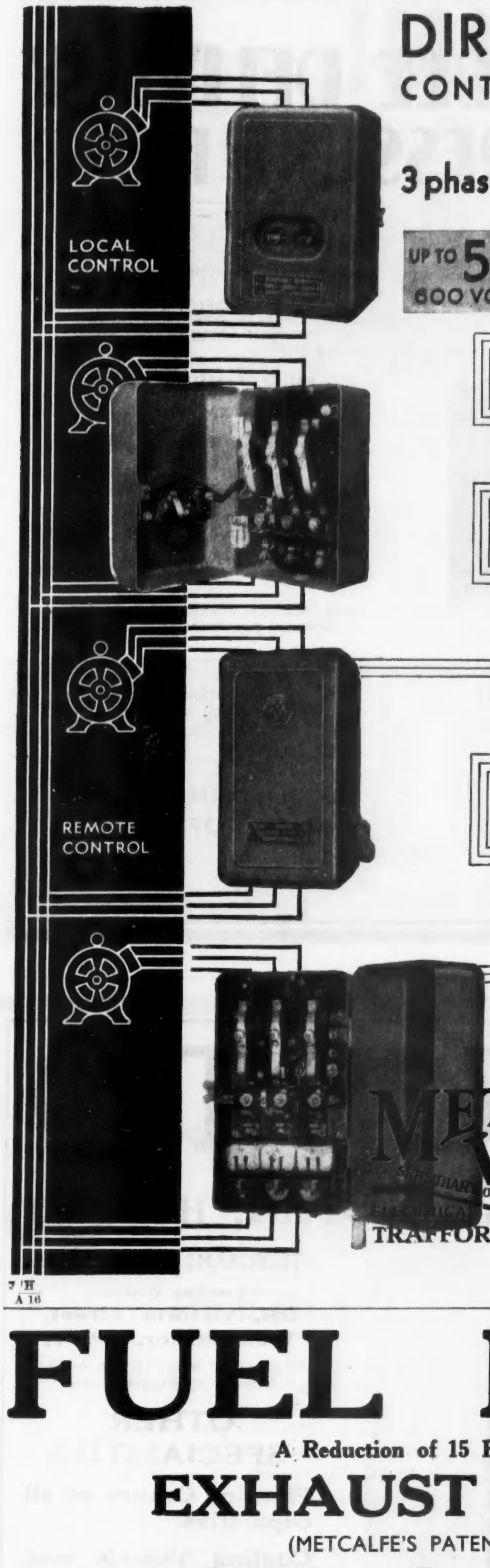

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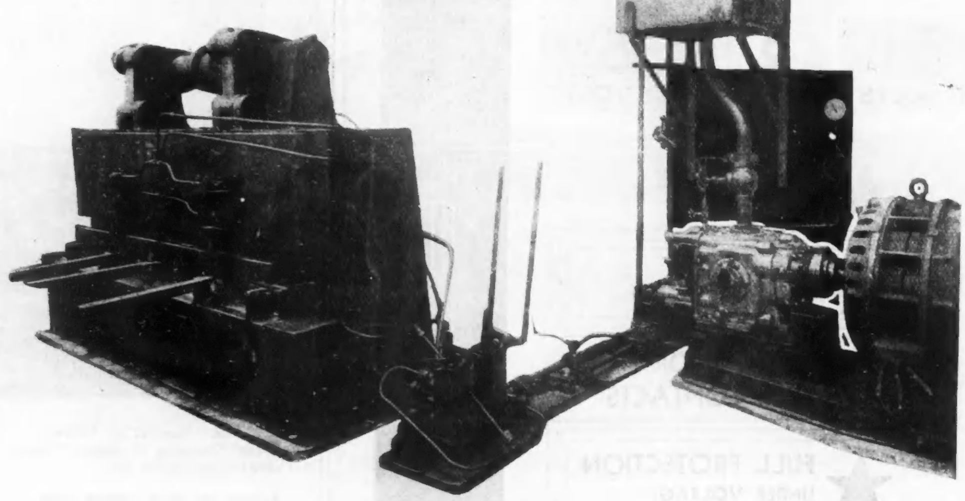

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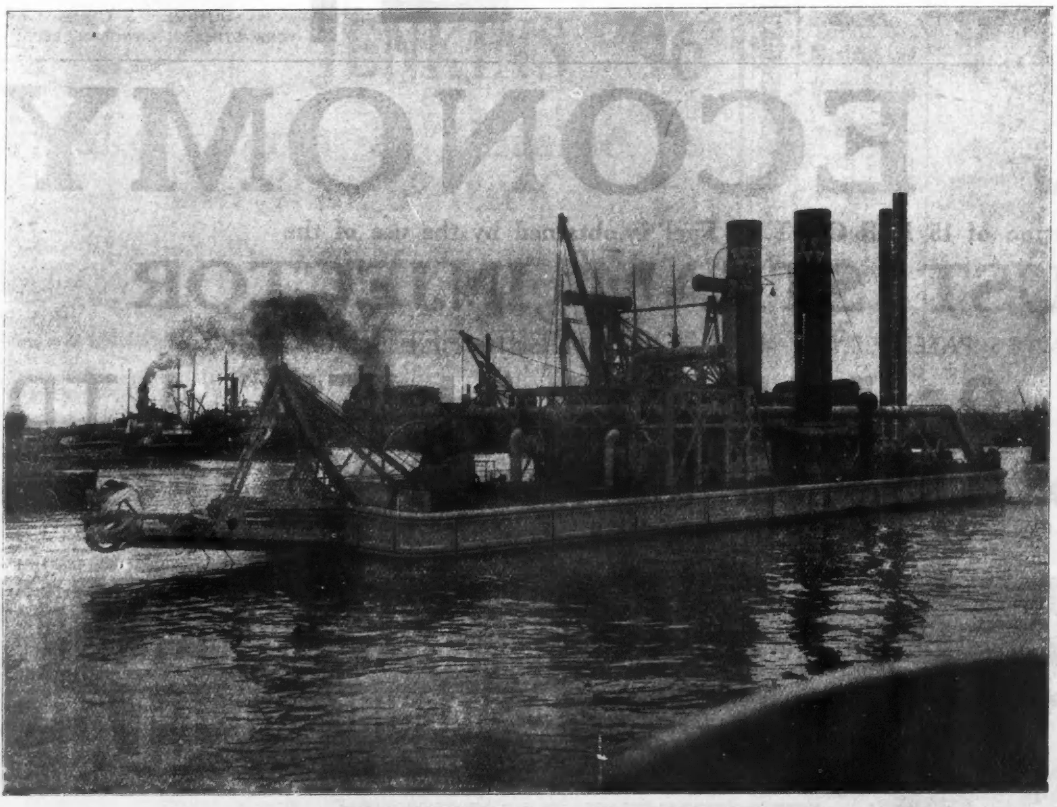

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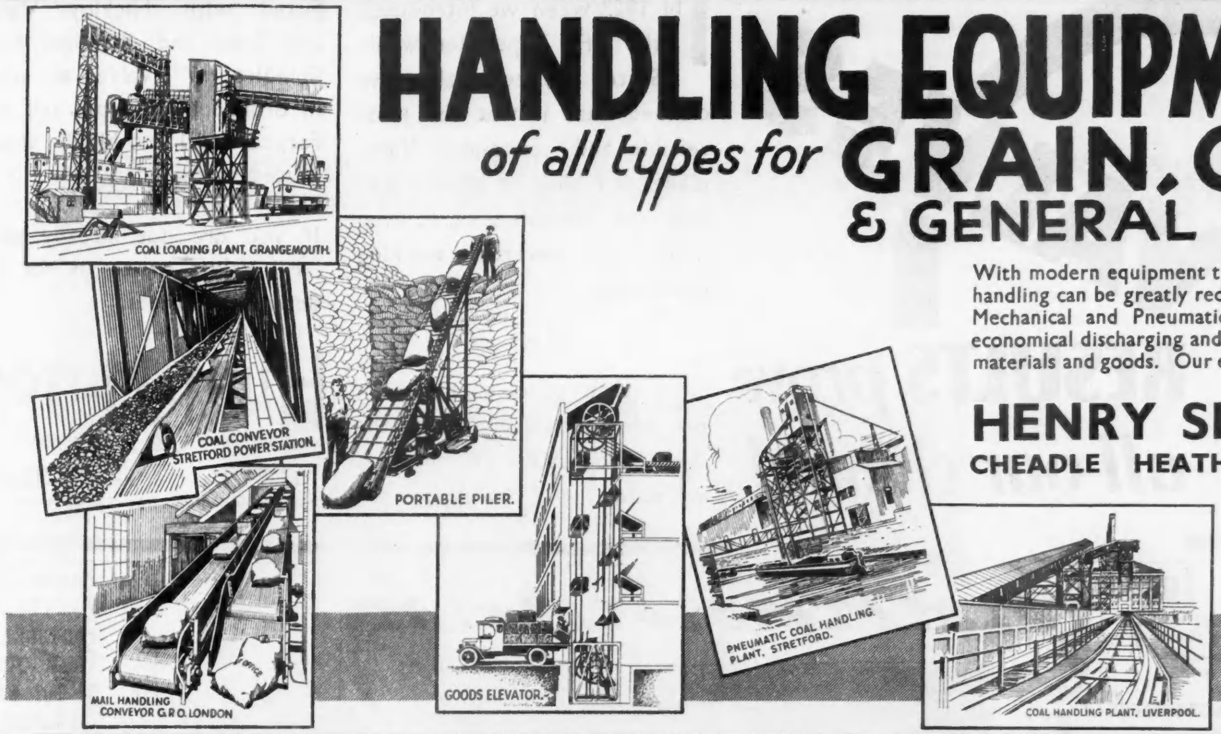
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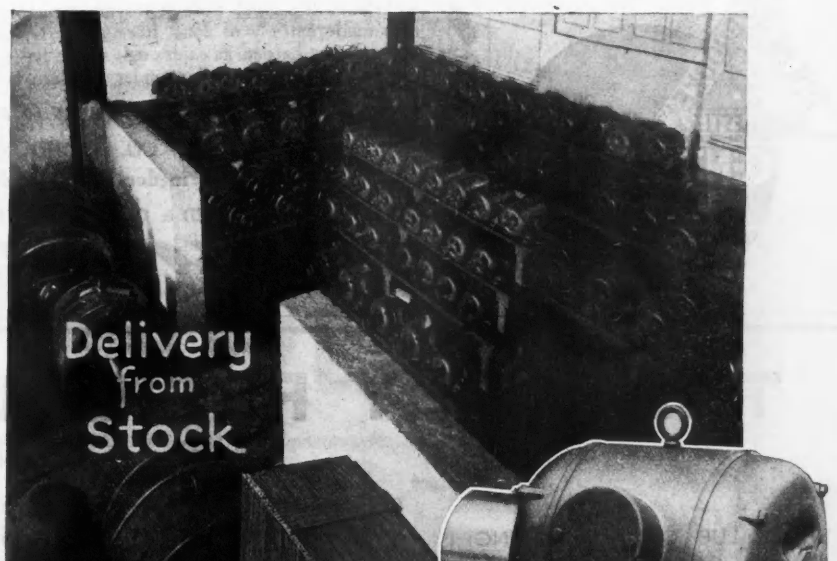
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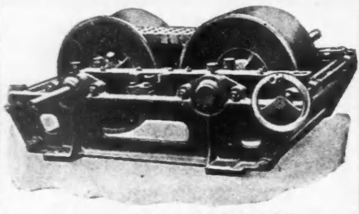

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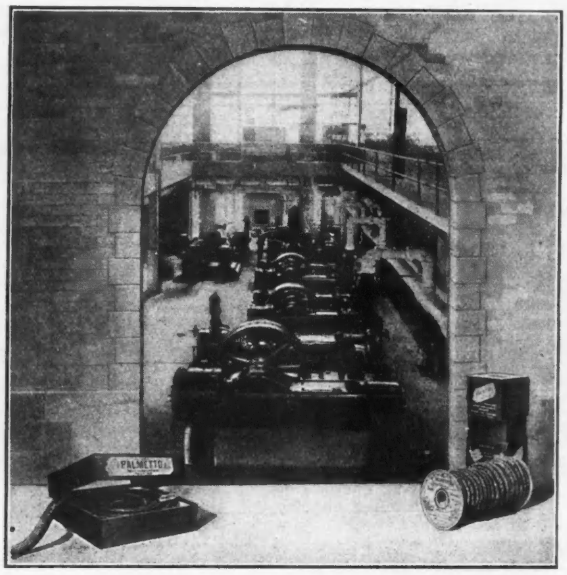

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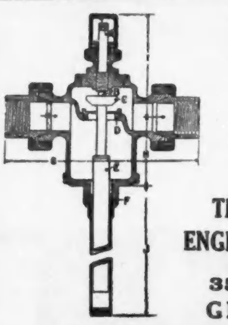

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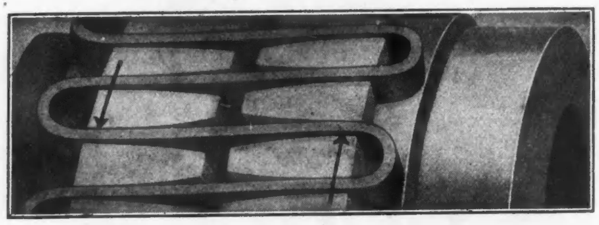

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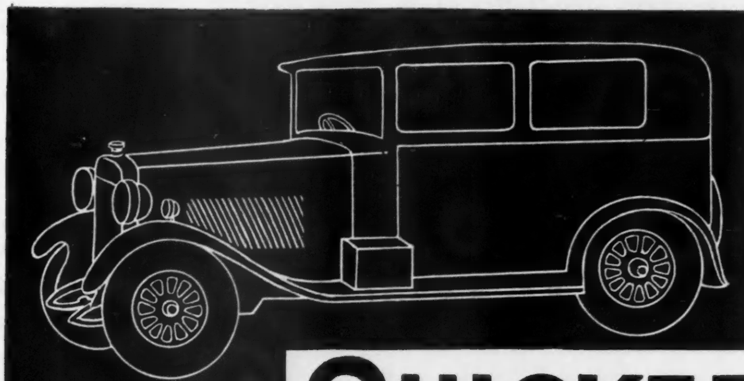

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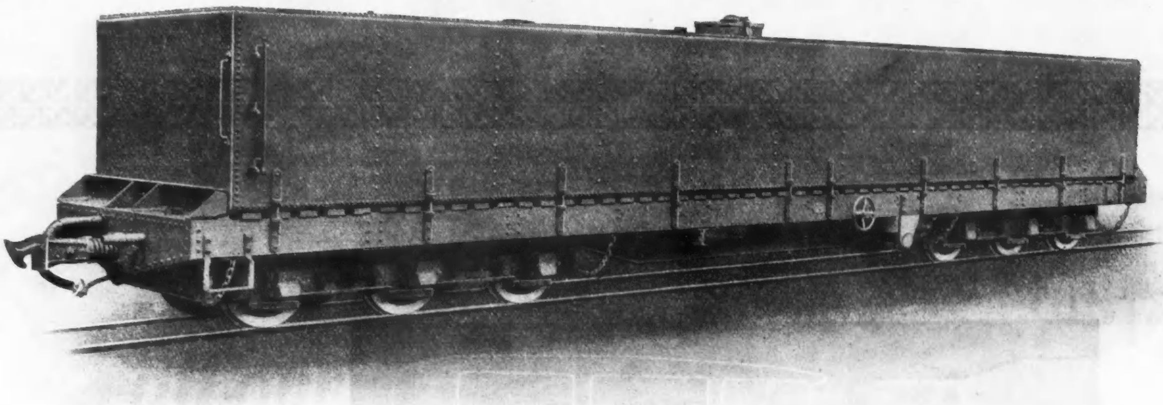

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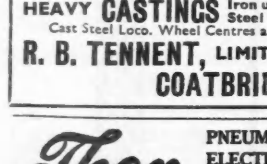

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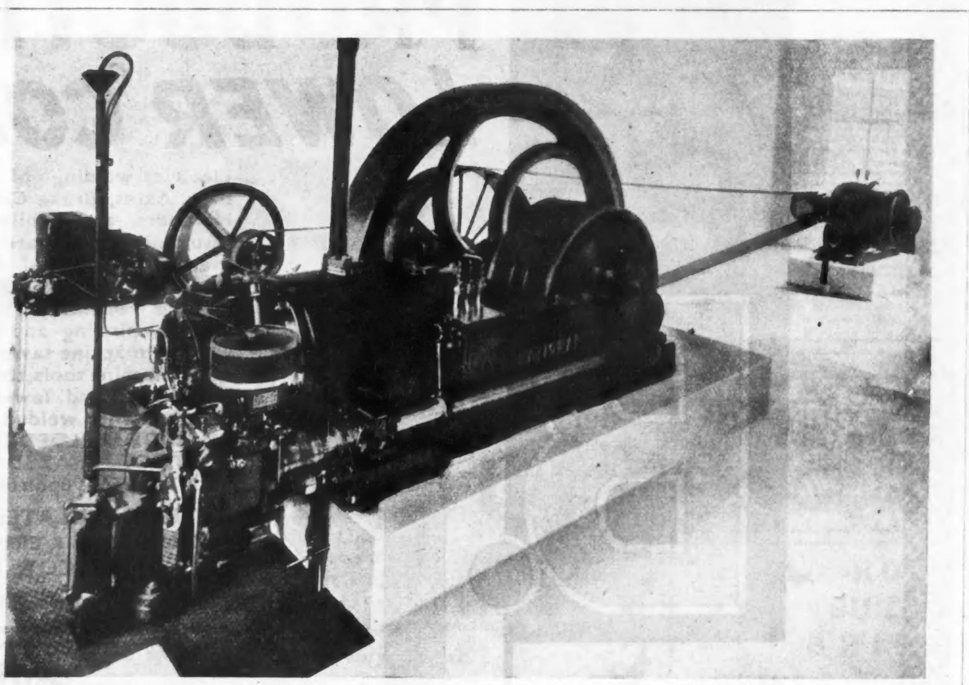

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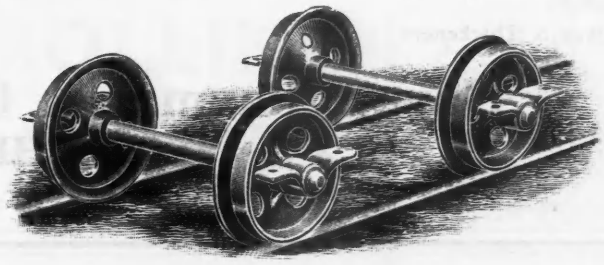

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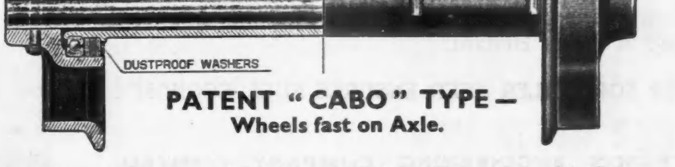

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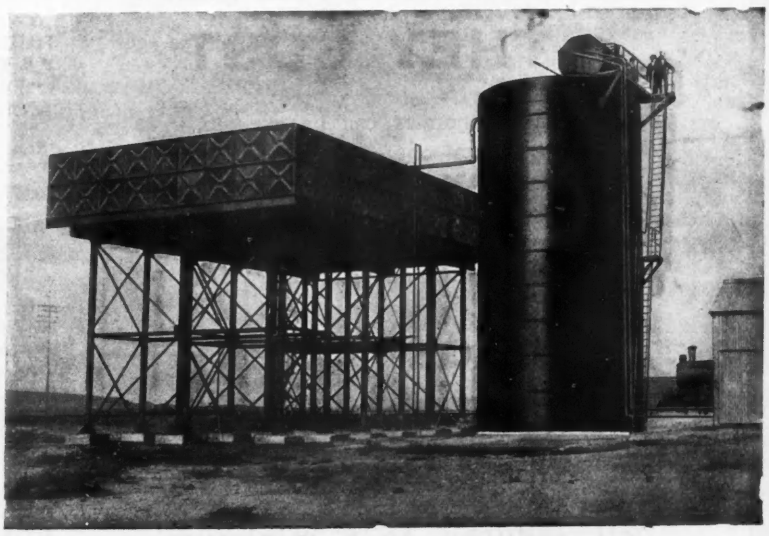

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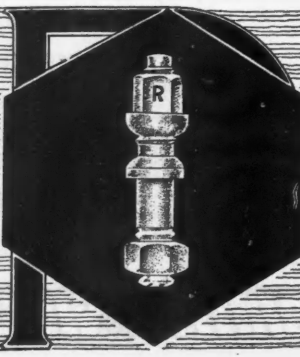

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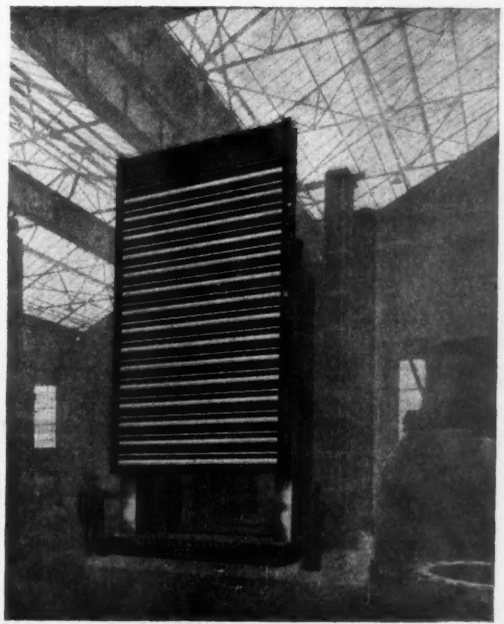

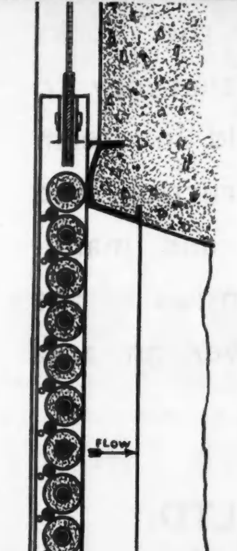

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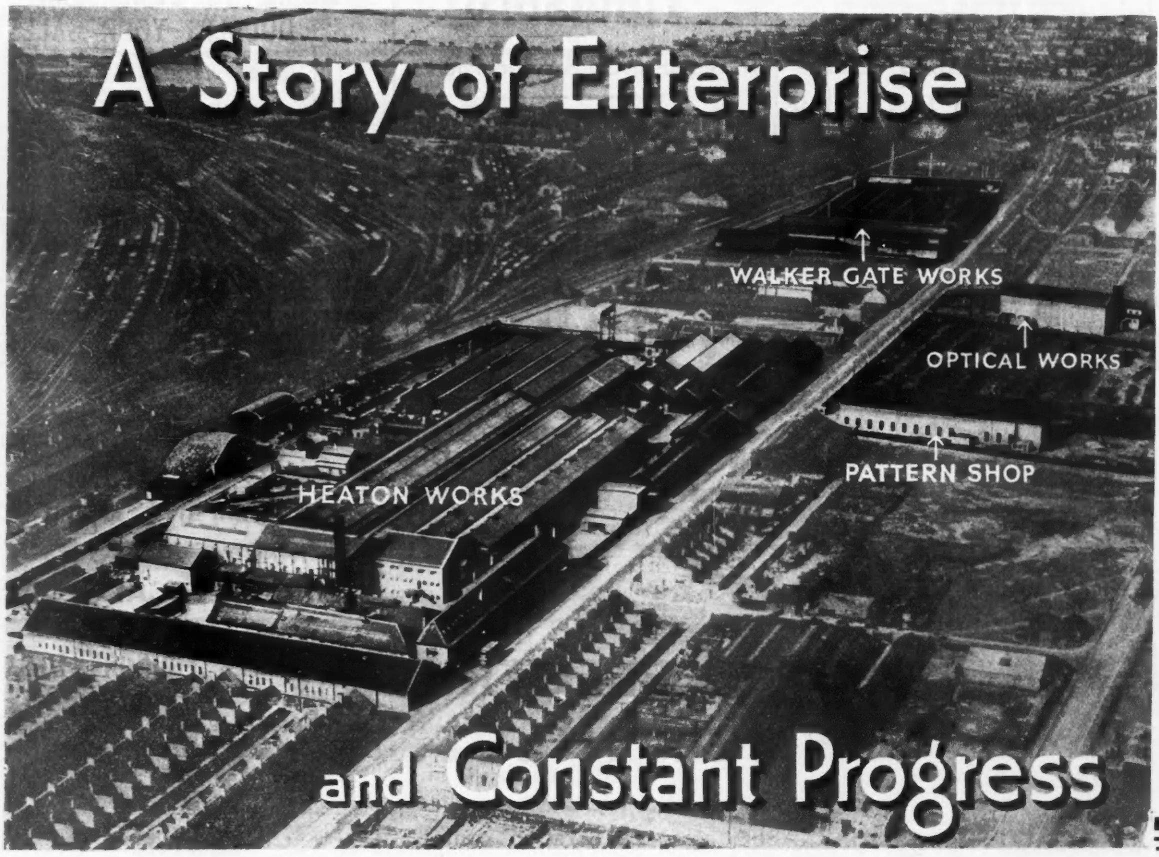
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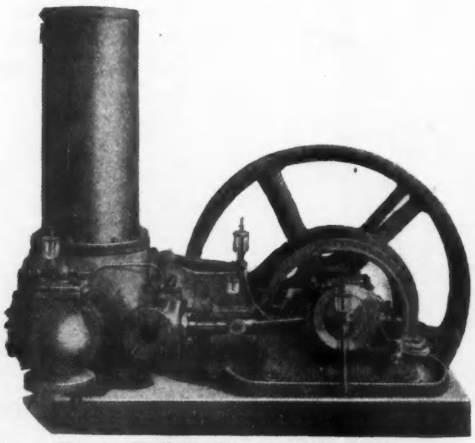

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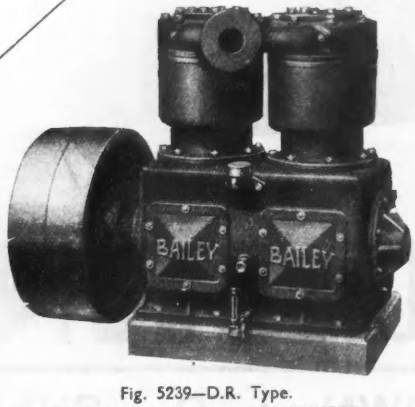

Fig. 5239—D.R. Type.
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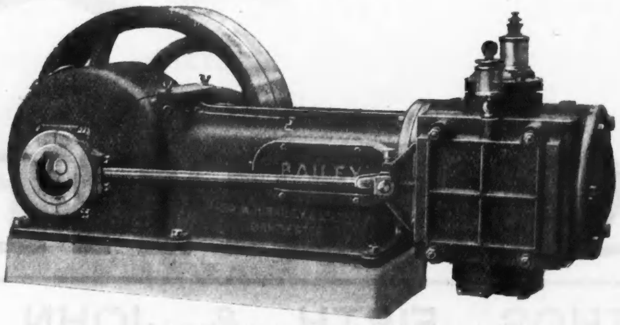

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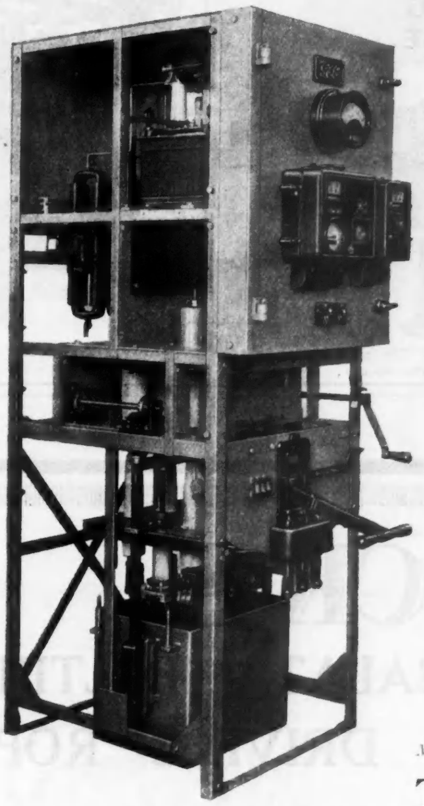

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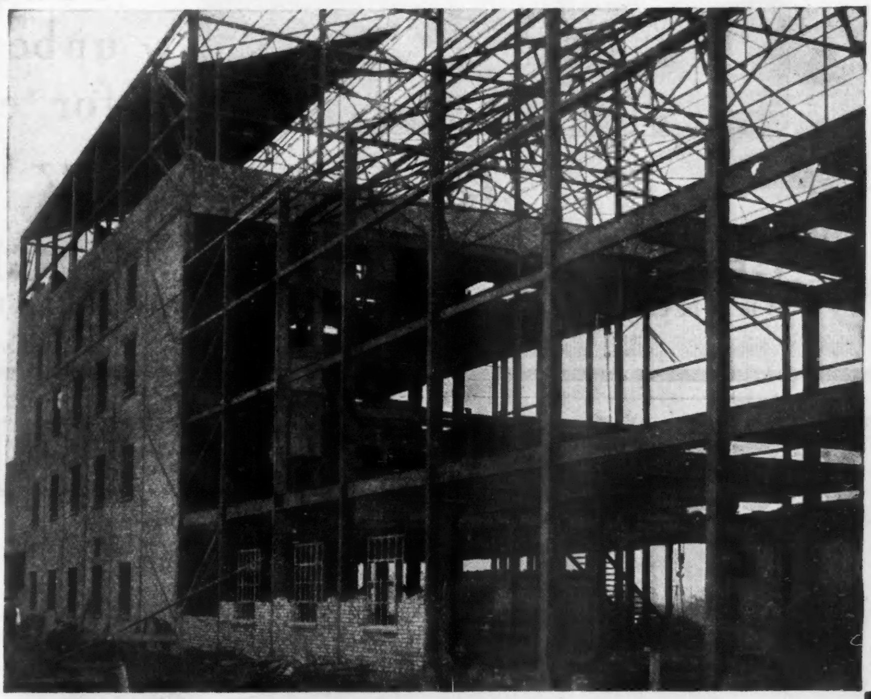

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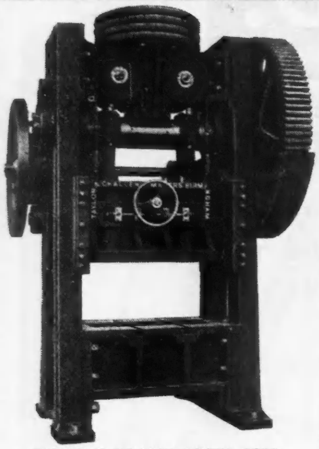

DOUBLE CRANK PRESS 1282.
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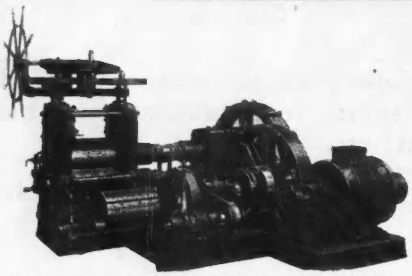

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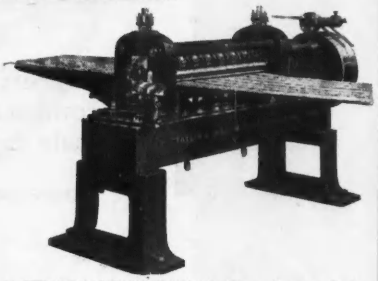

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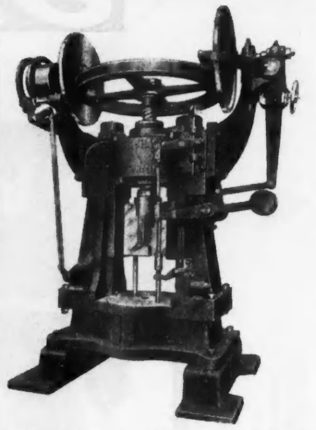
Weight—48 cwt.



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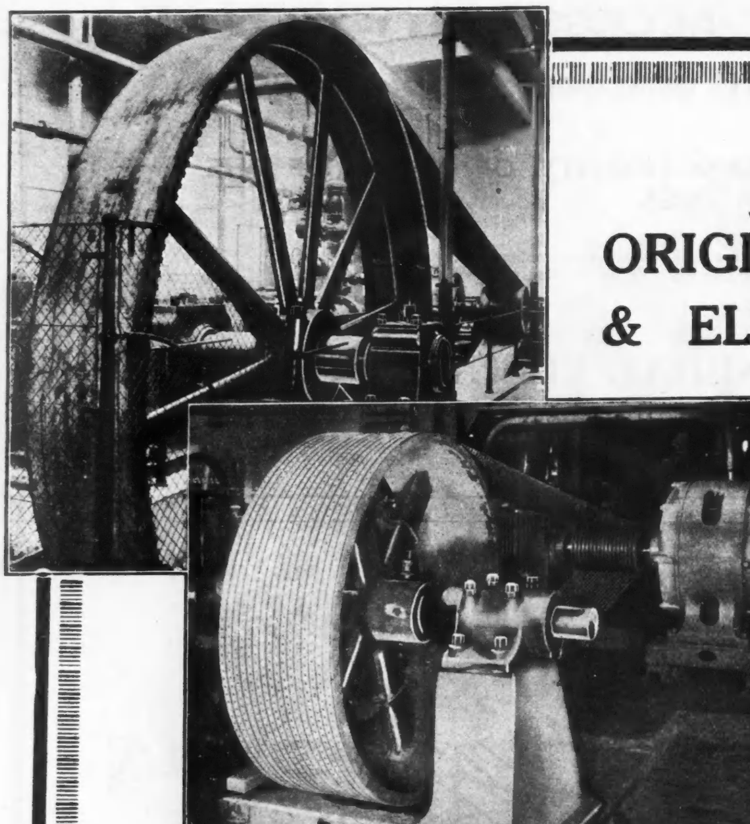
Weight—263 cwt.



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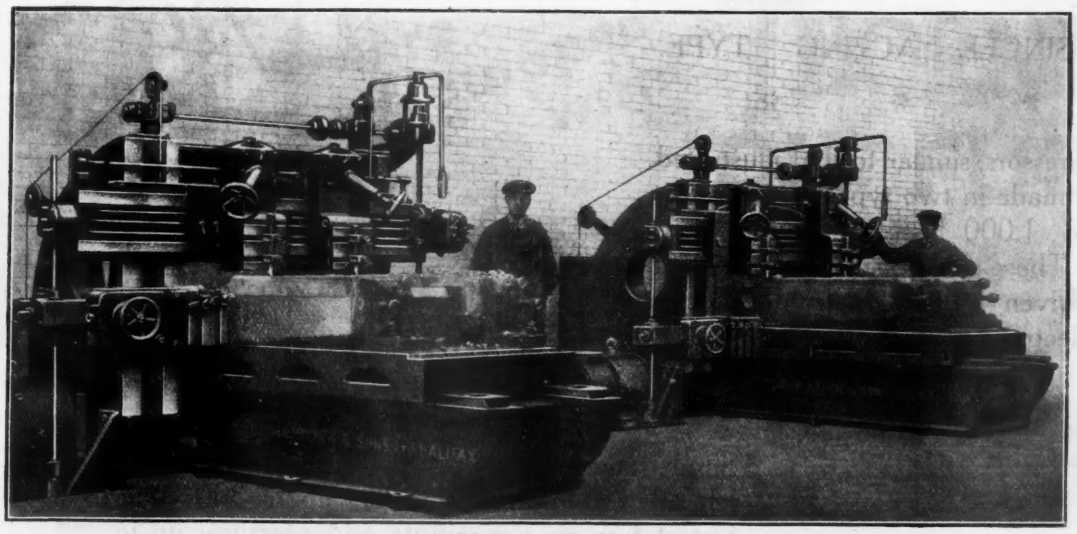

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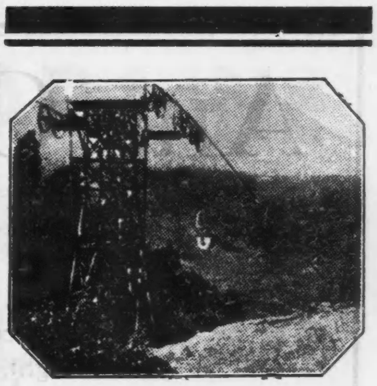

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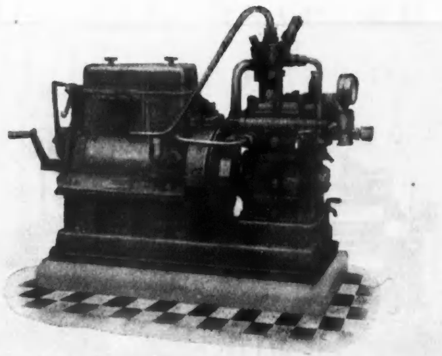

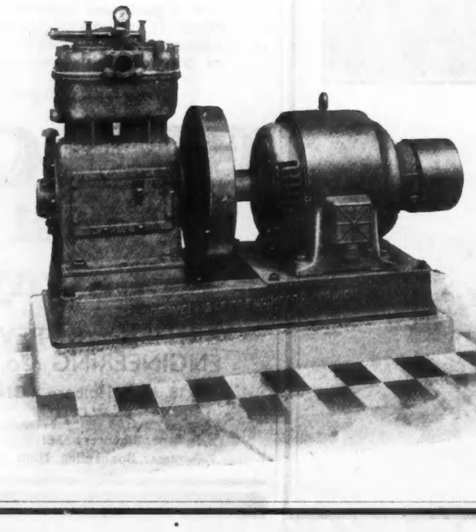

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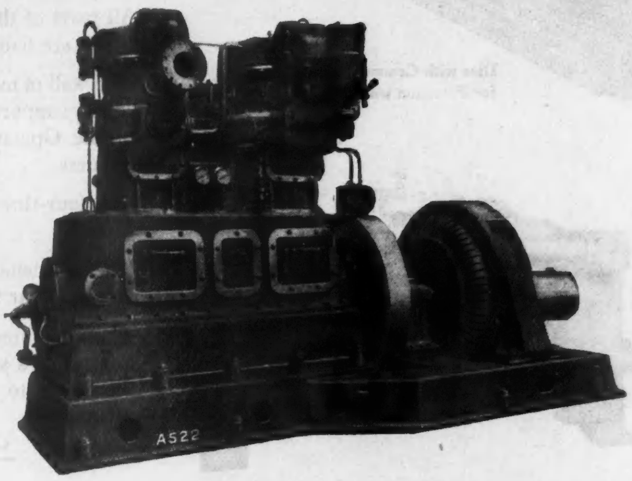

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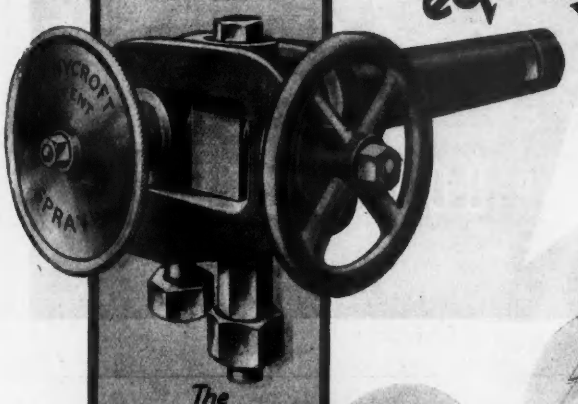

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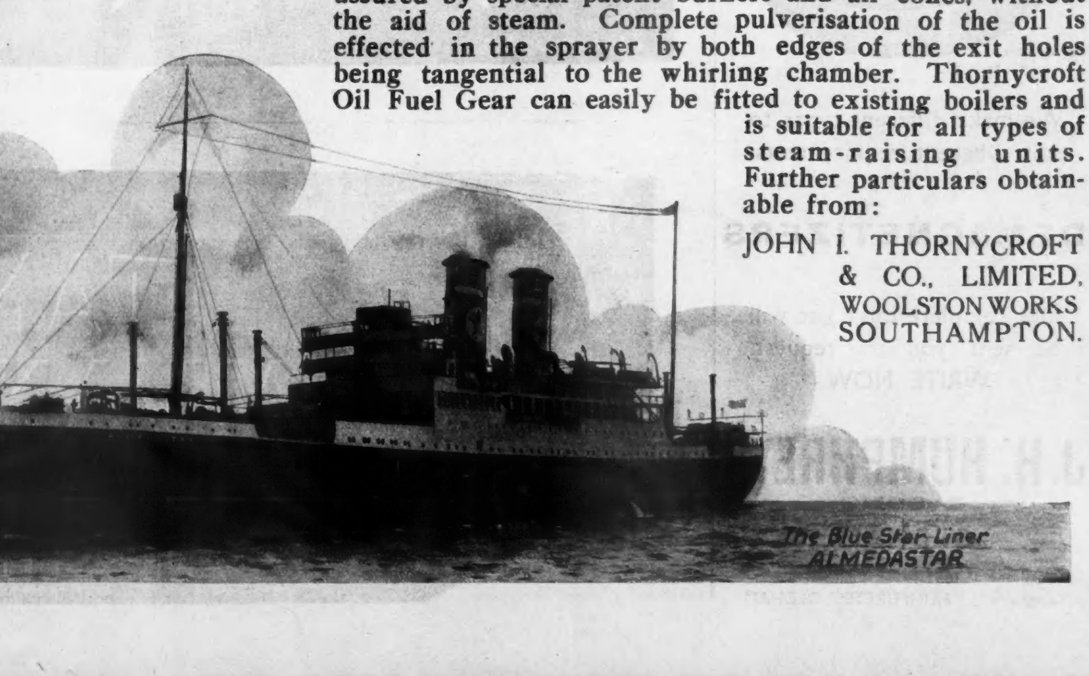

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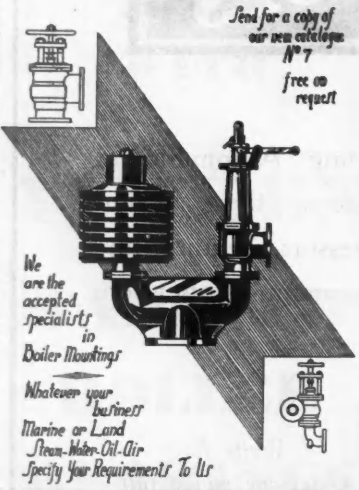

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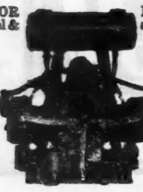

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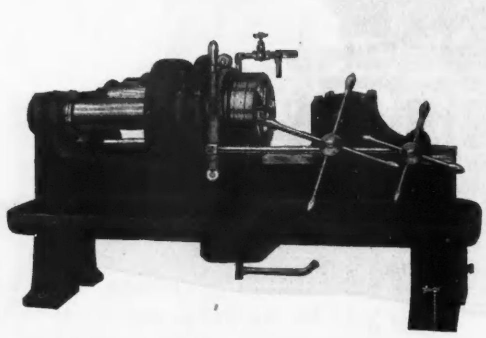

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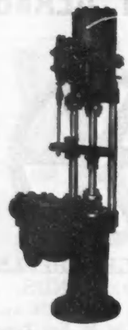

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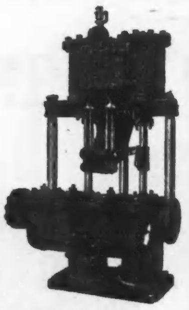

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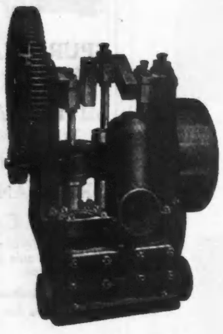

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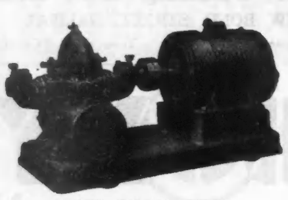

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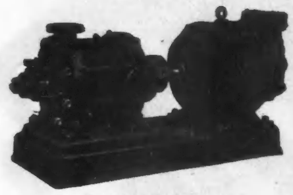

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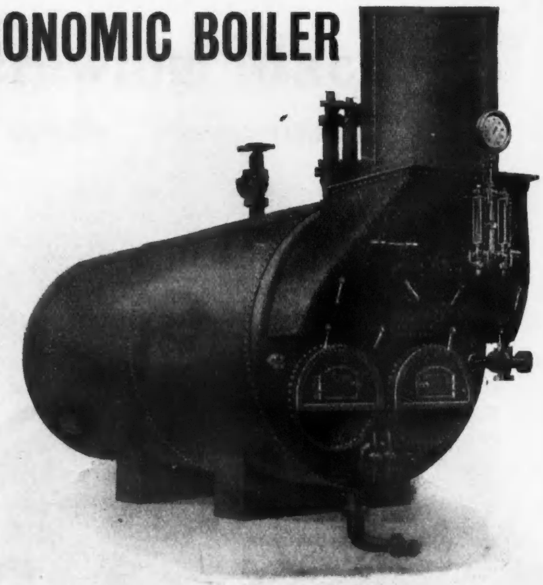

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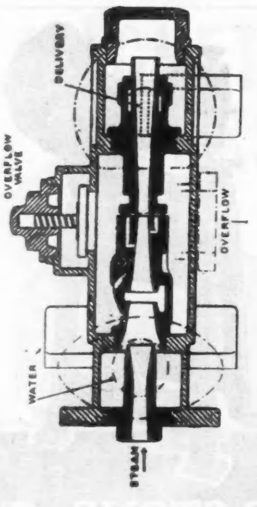

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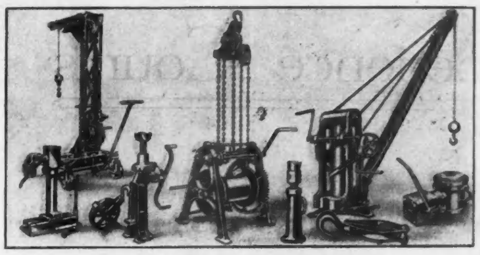

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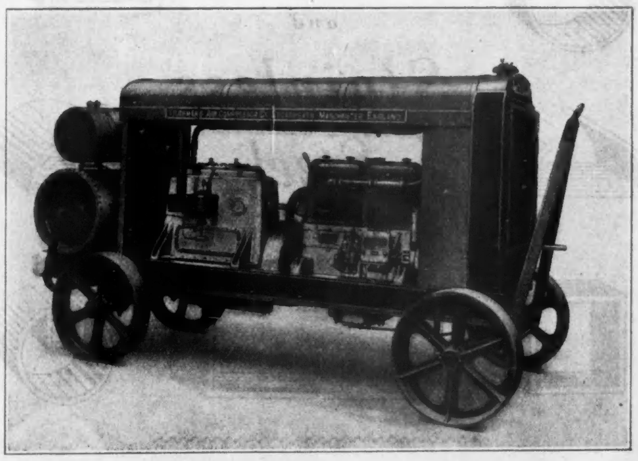

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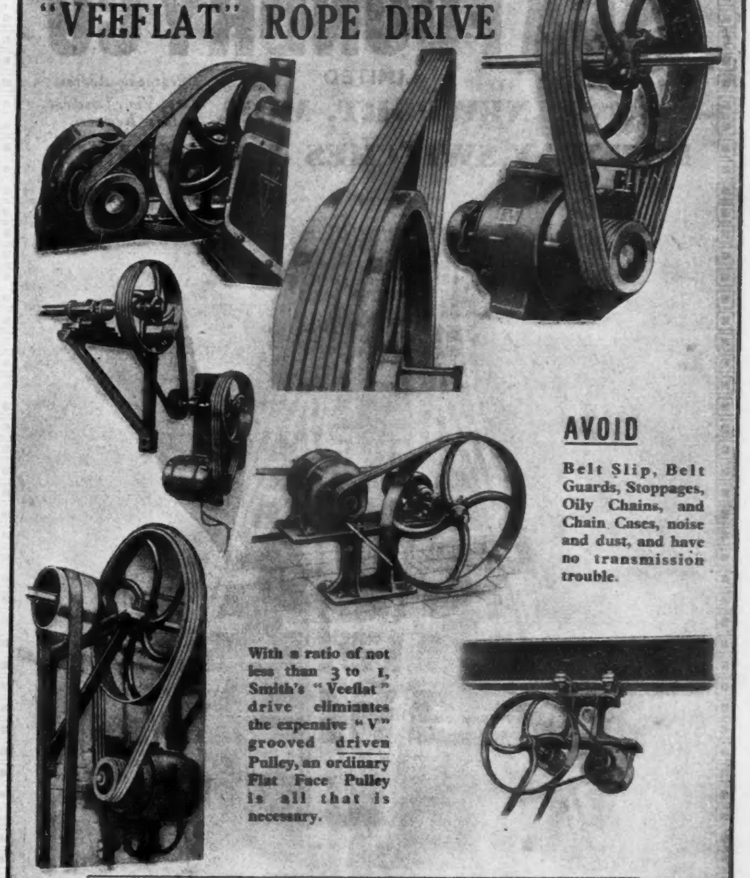

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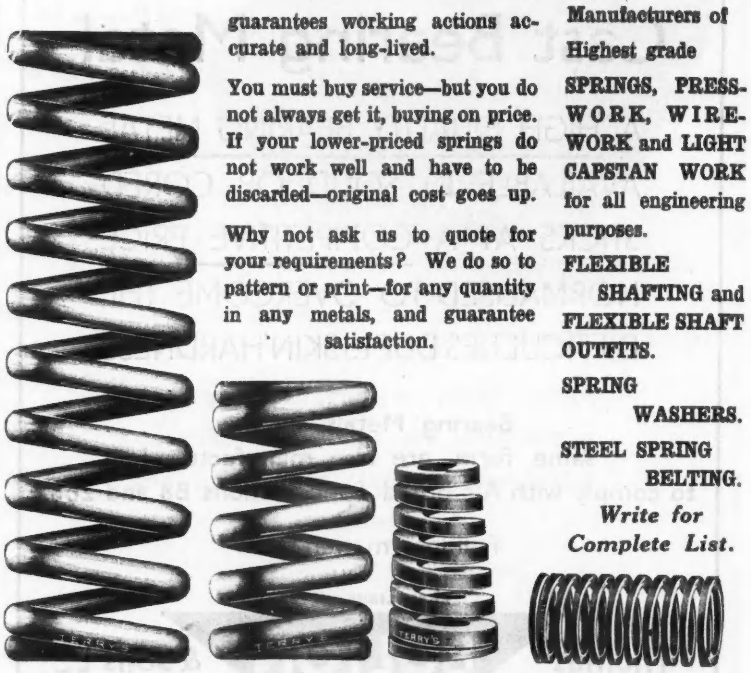

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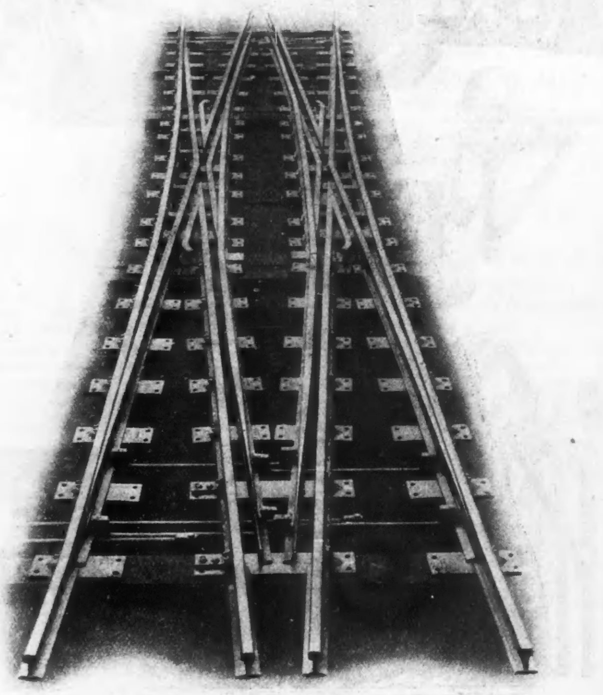

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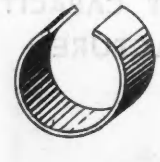

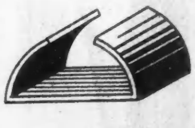

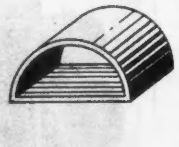

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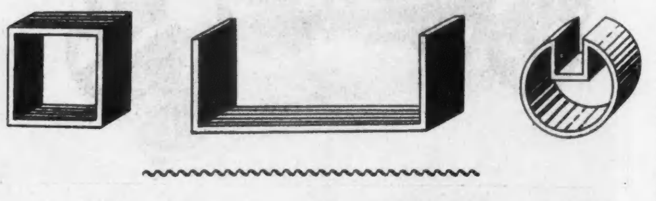

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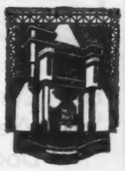

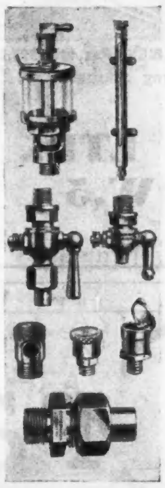

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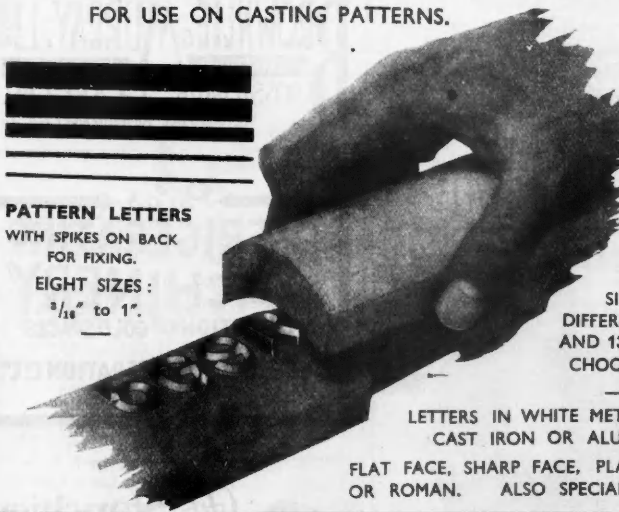

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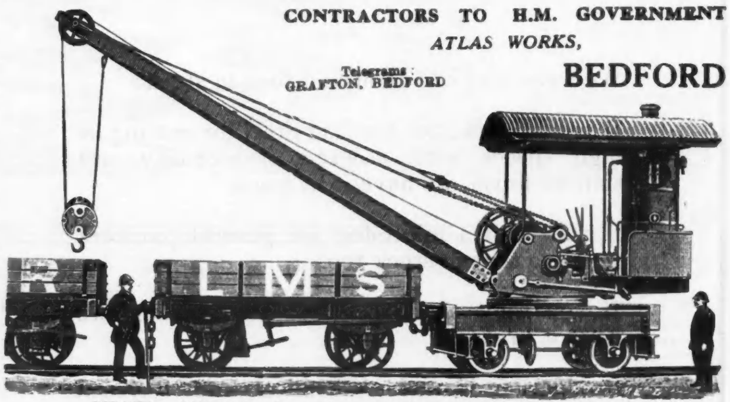

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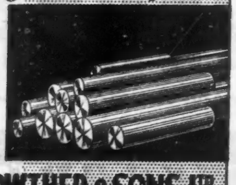

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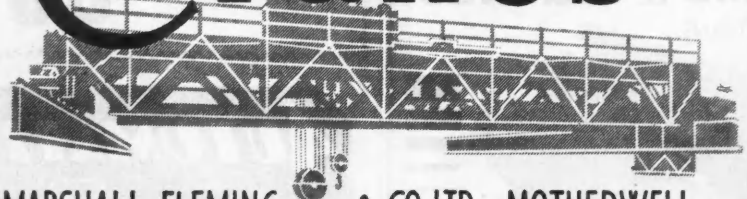

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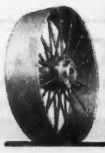

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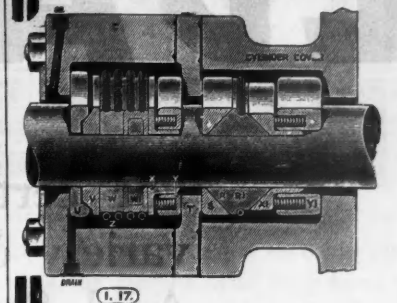

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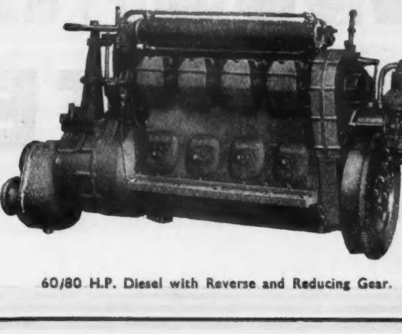

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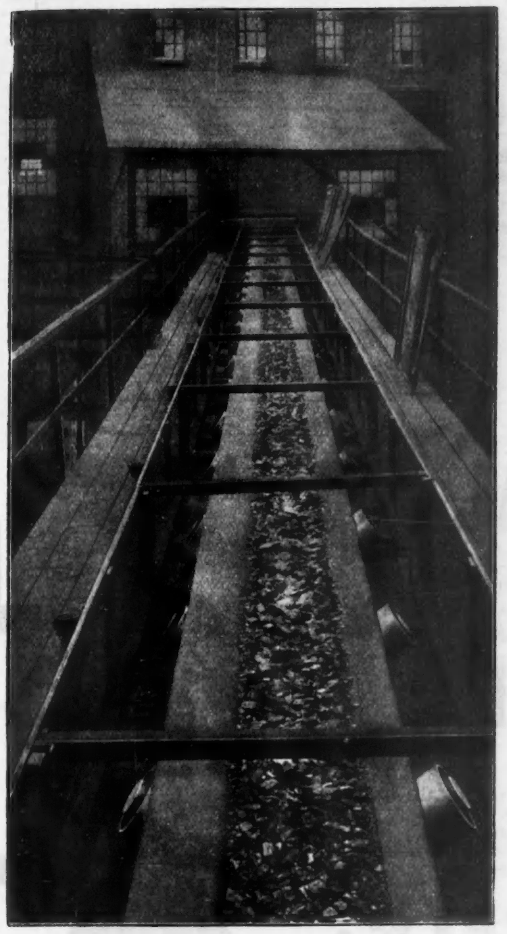

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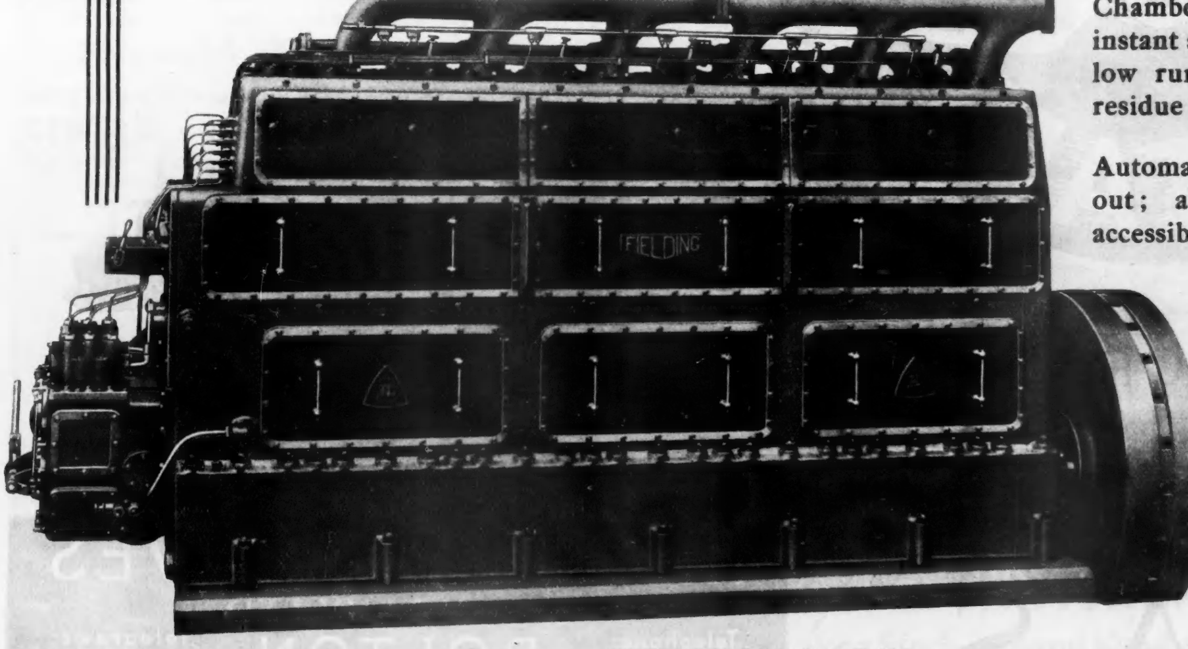

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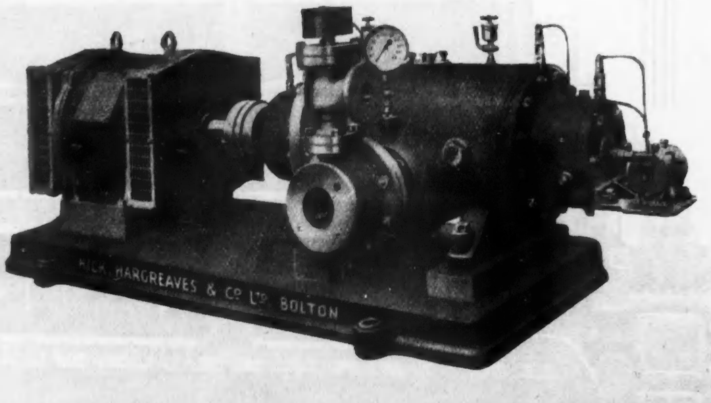

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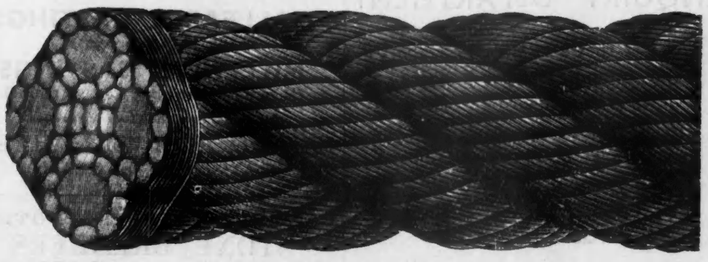

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